metal finishing

PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, METAL SPRAYING and all METAL FINISHING PROCESSES

Vol. 5 No. 51 (New Series) MARCH, 1959

GALVANIZERS

to the trade





ZINTEC PACKED FOR EXPORT

SUMMERS

. . . for ZINTEC

an electrolytically coated steel sheet

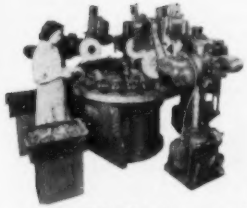
JOHN SUMMERS AND SONS LTD · HAWARDEN BRIDGE STEELWORKS · SHOTTON · CHESTER

CANNING

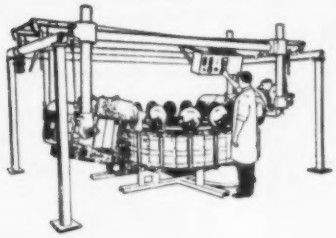
Automatic & Semi-automatic **POLISHING MACHINES**

NO SKILLED LABOUR ✳ REDUCTION IN POLISHING COSTS ✳ CONTINUITY OF OUTPUT

Uniflex Polishing Machine

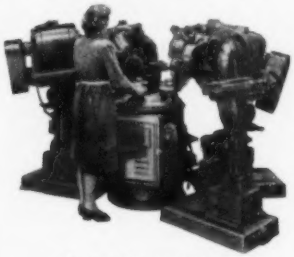


48" diam M/c. (Continuous type).





72" diam. M/c. (Indexing type).



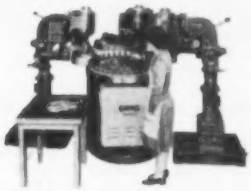
20" diam M/c. (Indexing type).

AUTOMATIC ROTARY TABLE POLISHING MACHINES

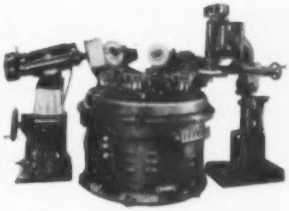
Suitable for a wide variety of articles ranging from small items such as pen caps to large diameter articles, viz. hub caps and domestic holloware.

Available with continuous or indexing tables according to requirements.

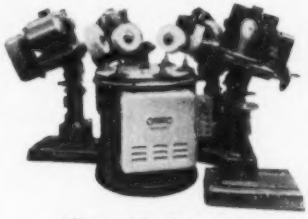
Please consult our experts for advice and further information.



30" diam. M/c. (Continuous type)



39" diam. M/c. (Indexing type).



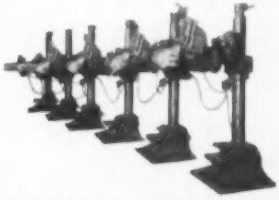
30" diam M/c. (Indexing type).

UNIFORMITY OF FINISH

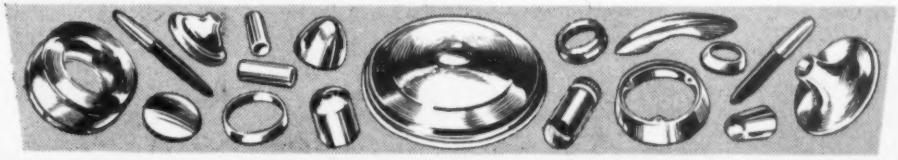
HIGH RATE OF PRODUCTION



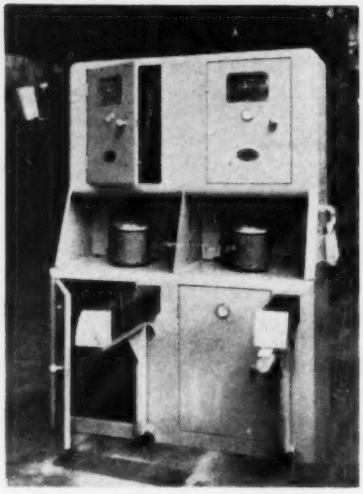
96" diam M/c. (Indexing type).



Light follower type Polishing Head.



CANNING GREAT HAMPTON ST. BIRMINGHAM 18. LONDON & SHEFFIELD

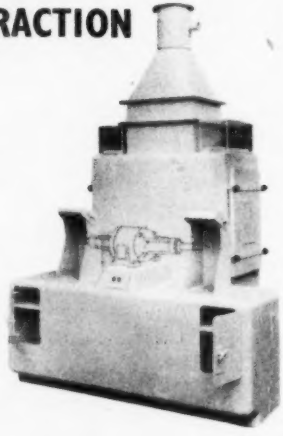


MOP DRESSING CABINETS

Normally the equipment required to coat with abrasive grit different kinds of mops consists of separate units, i.e., emery troughs, glue-pots and heaters, curing and drying cabinets, etc., but with these mop dressing cabinets all necessary requirements are contained in one compact assembly.

Heating can be effected either by steam or electricity, and thermostatically controlled in curing, drying and glue-pot sections. This is an essential item where super finishes are required.

WET SCRUB DUST EXTRACTION UNIT



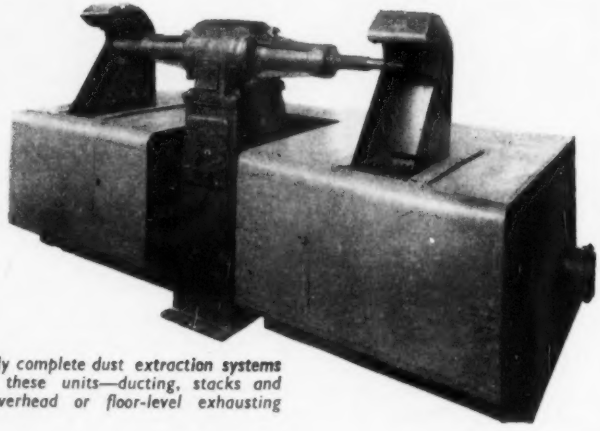
During the past few years there has been a considerable increase in the application of wet scrubbing of gases containing solid particles particularly to magnesium alloys and other metals which have an explosive contingency when broken down into particles.

The unit illustrated has been applied to a normal double-ended polishing or grinding spindle and its neat, clean appearance and compact arrangements are obvious.

Where dangerous dusts are collected a comprehensive range of automatic safety control gear is incorporated which complies with the Factory Act.

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These are ideal polishing Benches for small or medium sized components. Note the strong hoods, with ample adjustment provided ; the absence of ledges and sharp corners ; flush doors to operator's cupboards, and a large clear area for component storage.

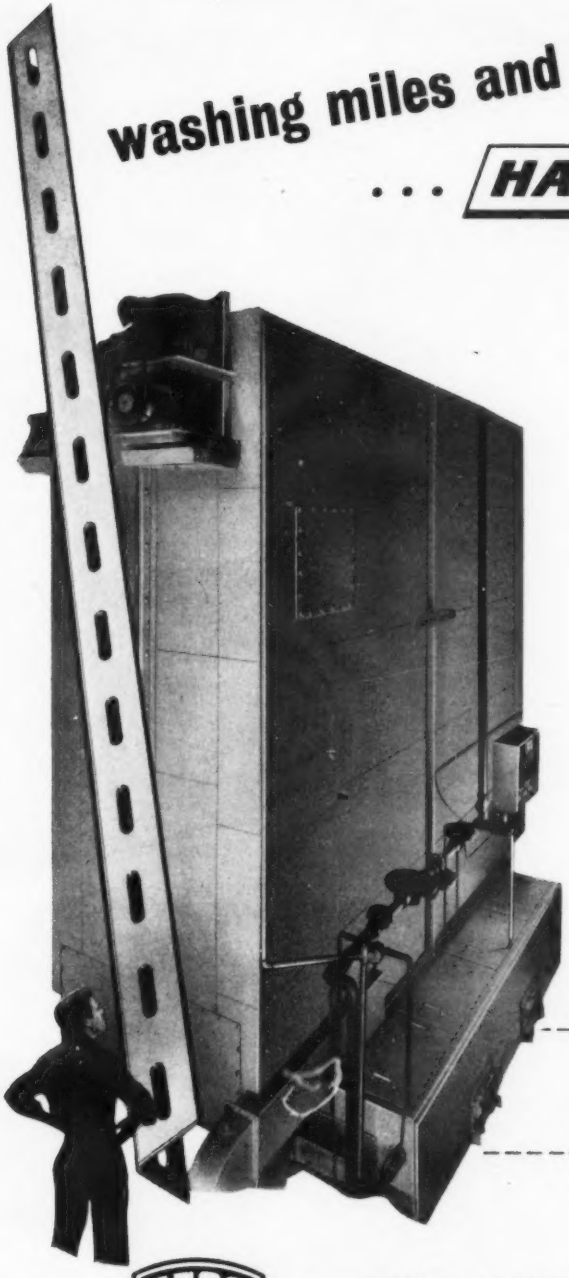


We also supply complete dust extraction systems suitable for these units—ducting, stacks and filters—for overhead or floor-level exhausting installations.

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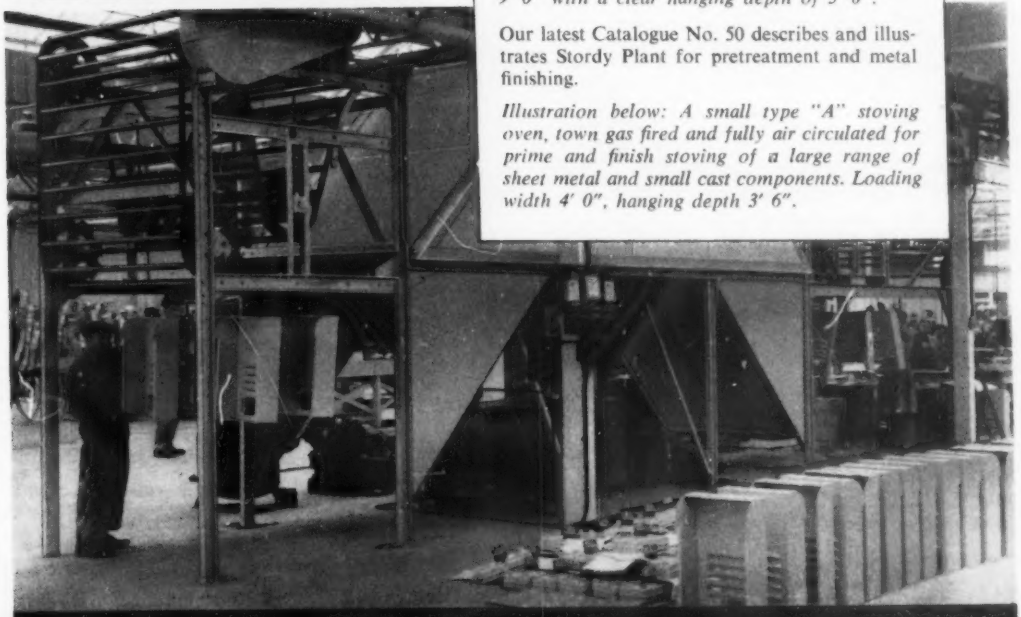
STORDY

LARGE OR SMALL CONTINUOUS 'A' TYPE OVENS FOR METAL FINISHING

Illustration above: A large gas fired air circulated "A" type stoving oven for both hand dipped and sprayed work, covering a wide size range and gauge of parts. Conveyor width 9' 0" with a clear hanging depth of 5' 0".

Our latest Catalogue No. 50 describes and illustrates Stordy Plant for pretreatment and metal finishing.

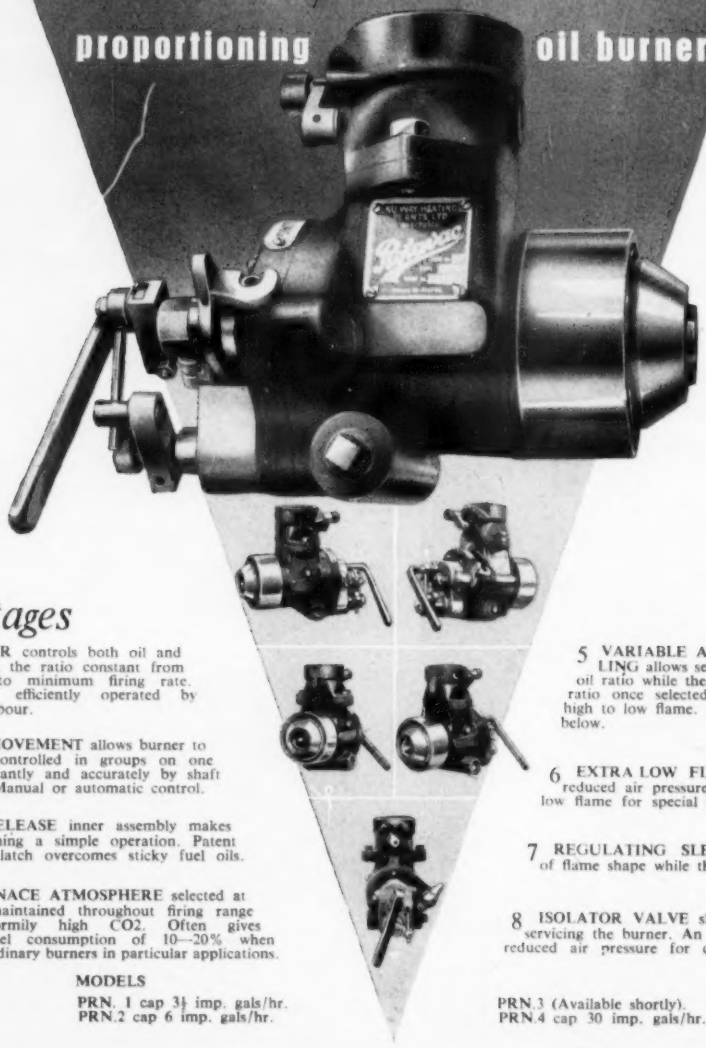
Illustration below: A small type "A" stoving oven, town gas fired and fully air circulated for prime and finish stoving of a large range of sheet metal and small cast components. Loading width 4' 0", hanging depth 3' 6".



STORDY ENGINEERING LIMITED
CUMBRIA HOUSE · GOLDTHORN HILL · WOLVERHAMPTON

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PRN.2 cap 6 imp. gals/hr.

5 VARIABLE AIR/OIL VALVE COUPLING allows selection of the correct air/oil ratio while the burner is running. Any ratio once selected remains constant from high to low flame. For extra low flame see below.

6 EXTRA LOW FLAME SHIELD provides reduced air pressure to give a smaller stable low flame for special applications.

7 REGULATING SLEEVE allows adjustment of flame shape while the burner is in operation.

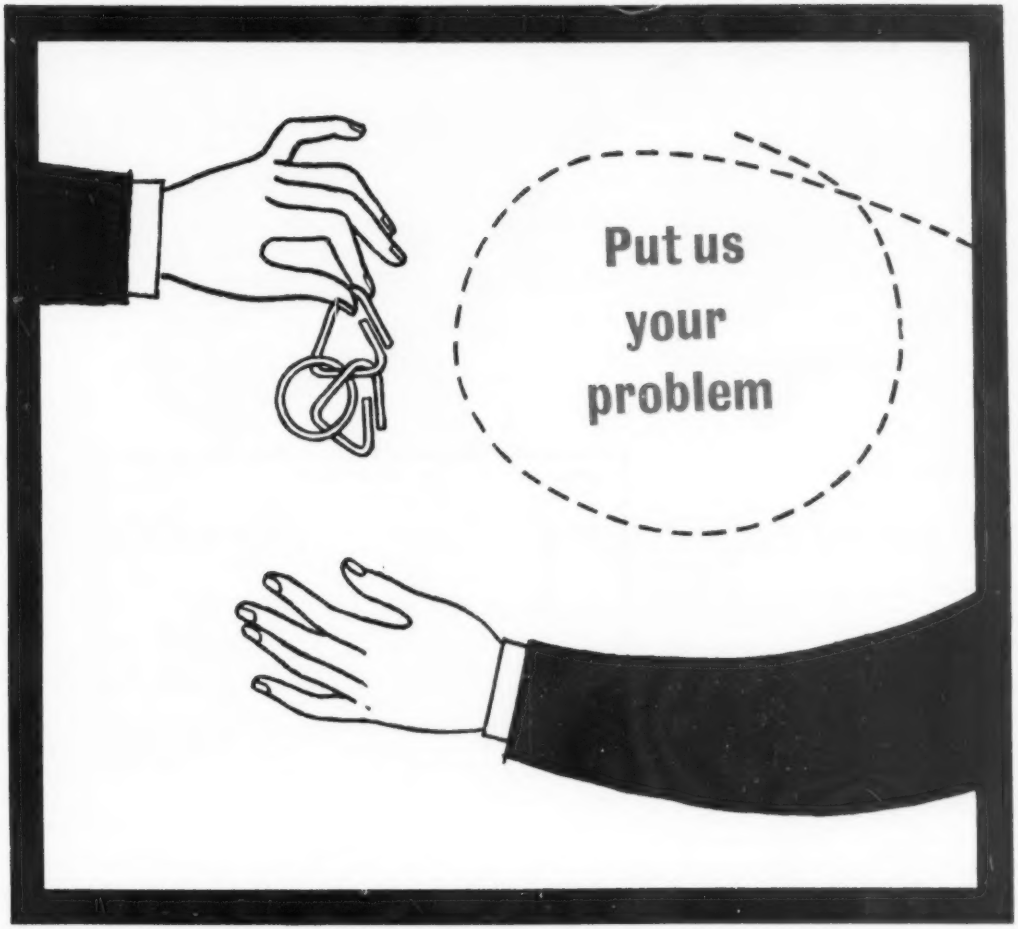
8 ISOLATOR VALVE shuts off air supply when servicing the burner. An intermediate setting gives reduced air pressure for quicker, simpler lighting.

PRN.3 (Available shortly).
PRN.4 cap 30 imp. gals/hr.

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ME6

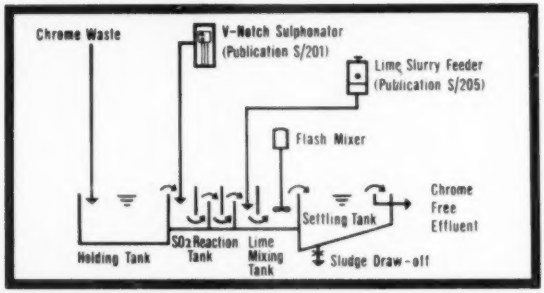
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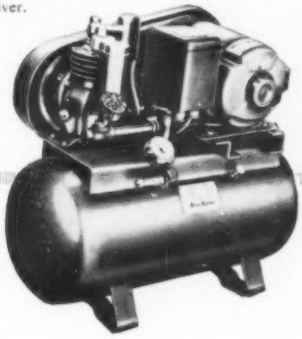
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PE 2 RAS. Single stage, one cylinder, fully automatic compressor unit with 0.5 hp motor with 1.42/cu.ft. horizontal air receiver.



Complete small compressor range by Atlas Copco

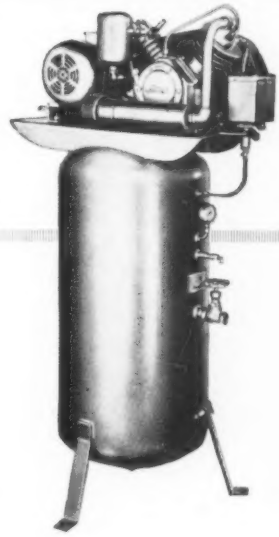
Small workshops or garages where the need for compressed air is limited can find a small compressor which will suit their needs exactly in Atlas Copco's complete range. Here are a few thing they will power: *Paint spraying—car hoisting—air for tyres—forced feed lubrication—sand blasting—metal and wood drilling—grinding—screwing and tapping—metal shearing—hoists—plug hole drilling—rivetting—engraving—stone grinding and polishing—operating door openers, etc.*

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WORLD-WIDE SALES AND SERVICE

Atlas Copco manufacture portable and stationary compressors, rock-drilling equipment, loaders, pneumatic tools and paint-spraying equipment. These are sold and serviced by companies or agents in ninety countries throughout the world.



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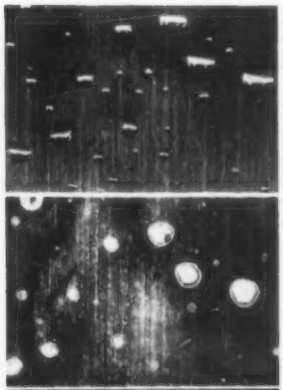
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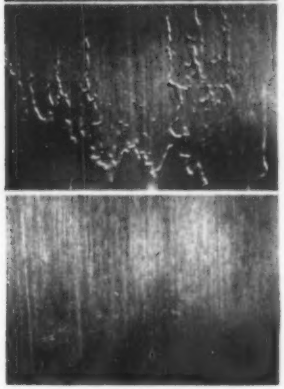
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'Trisec' Metal Drying Assistant is a new product of I.C.I., for use in modified I.C.I. degreasing plants. 'Trisec' is ideal for the rapid drying of metal after aqueous processes, such as electroplating, electropolishing, phosphating, chromating, contour etching, pickling, alkaline de-rusting, etc. 'Trisec' is used as an additive to trichloroethylene (1 part to 80) to displace water from metal articles, leaving them completely stain-free. Hot rinses, hot air ovens, wiping and sawdust barrelling are therefore eliminated by using 'Trisec' metal drying assistant.



ABOVE *Without 'Trisec' Metal Drying Assistant, drops of water on a sheet of metal (top) leave stains on evaporation (bottom).*

BELOW *With 'Trisec' Metal Drying Assistant, the water film is displaced (top) leaving no stains (bottom).*



'TRISEC'
metal drying assistant

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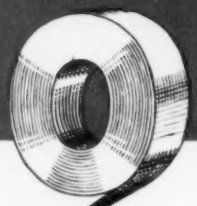
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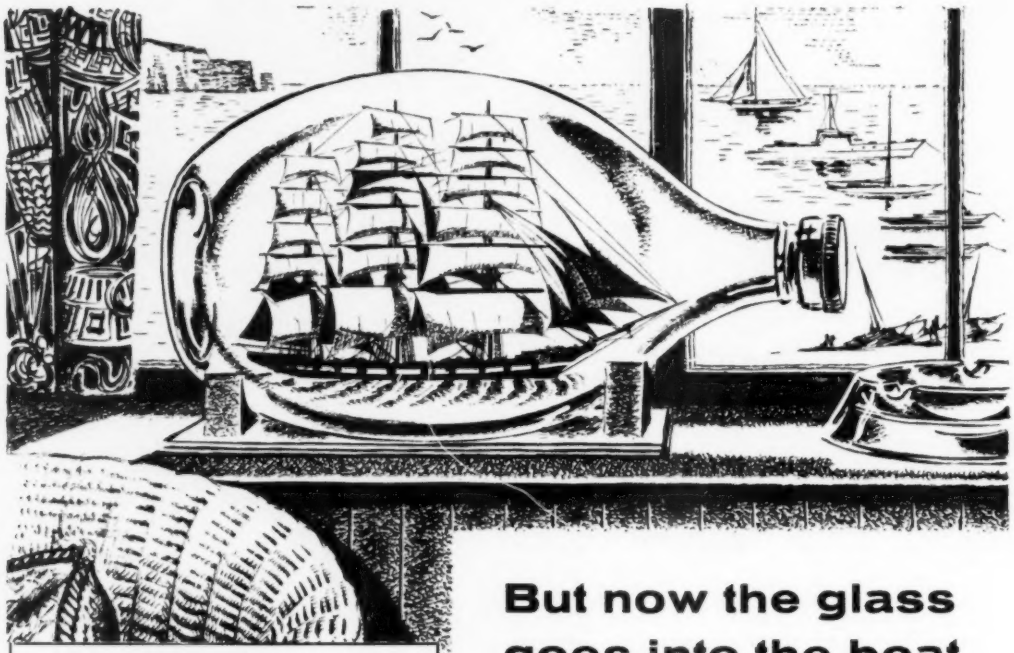


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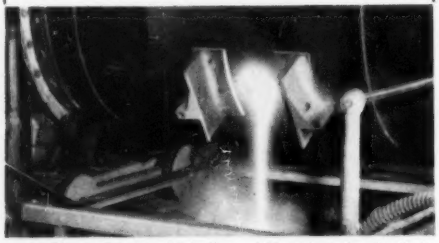
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(Photo: Courtesy Main Enamel Manufacturing Co. Ltd)

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metal finishing Journal

March, 1959 Vol. 5, No. 51 (New Series)

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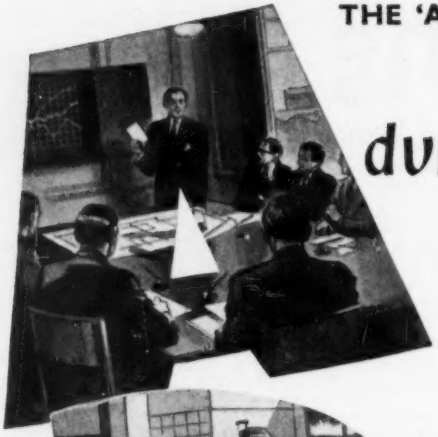
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SCIENCE A LA MODE

ANY student of the history of science must have observed that there have been, and still are, fashions in thought which are almost as erratic in their vagaries and as evocative of loyal support from their adherents as are the changing modes and styles of feminine wear. The scientific method is to observe facts and to deduce from them a hypothesis which provides a theoretical background with which none of the observed facts is in conflict. The highway along which scientific knowledge has evolved to its present form is fraught with well-explored blind alleys and littered with the wrecks of abandoned hypotheses, many of which, as for example, phlogiston and the aether, held sway in men's minds for not inconsiderable periods.

The success of this method must depend on the integrity and liberality of the minds involved, and progress is halted when observed facts are distorted or ignored in order to bolster up the acceptability of an otherwise attractive hypothesis.

This is perhaps a rather roundabout and pontifical way of drawing attention to the simple truth that facts are more significant than theories, and one would have thought that there would have been little need for emphasising such an obvious truism in an enlightened community, were it not for the fact that there is ample evidence, in many walks of life, of man's reluctance to abandon a cherished belief, even when faced with incontrovertible facts which render that belief untenable. Those who regarded the gravitational demonstration of Galileo at the leaning tower of Pisa as a dexterous piece of leger-de-main are the spiritual ancestors of the works manager who refuses to believe that his department is operating at a loss, in spite of all the evidence to the contrary that the accountants can produce.

Progress therefore involves the need for a series of sometimes major, sometimes minor, revolutions in thought, and it would appear that there is every possibility of a small volte-face taking place currently with regard to the corrosion resistance of the widely popular chromium over nickel plate. For many years it has been the accepted and unchallenged view that nickel, an intrinsically corrosion resistant metal, provided effective protection to the underlying steel, and that corrosion only occurred at pores or similar discontinuities in the nickel plate. The presence of these pores was attributed to some property of the plating process itself and could be avoided or reduced by increasing the thickness of the coating. Nickel, while corrosion resistant, is susceptible to tarnishing and this tendency is countered by the extremely thin overlying deposit of chromium. A simple mechanism and one which has accounted for most of the hitherto observed facts.

It now appears however, in the light of work being done to reduce the porosity of thin nickel electrodeposits that many of the pores through which corrosion of the underlying metal has occurred, were not present in the as-deposited nickel but have arisen rapidly in service as a result of concentrated attack at discontinuities in the chromium layer. Thus it may well be more profitable from the point of view of service life of the finish to concentrate on eliminating the discontinuities from the chromium rather than from the nickel.

Talking Points

by "PLATELAYER"

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

REMOTE CONTROL

ONE might have expected that with the vast amount of out-doors all around us, and seeing what happens to finishes when they are exposed to it for long almost anywhere, there would not be much difficulty in performing outdoor exposure tests. Yet finding the right kind of outdoors for such tests seems to be quite a problem and many organizations are prepared to go quite a long way for it. The British Non-Ferrous Metals Research Association likes Chichester, one of the largest of our paint manufacturers, located in the Home

new cyclotron at Glasgow University are kept small by water cooling through a central duct; the strands of cable which surround this duct are insulated with polythene.

Water cooling is being used to an increasing extent for rectifiers in electroplating, so there seems no good reason why water-cooled bus bars should not be employed also, particularly as the water could then be used in rinse tanks. The cost of putting water channels in the bus bars should be quite small.

This raises the further possibility of combining



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Recent Developments in CHROMIUM PLATING‡

by D. E. WEIMER*

CHROMIUM deposition is principally carried out from chromic acid solutions containing small percentages of catalysing ions. While chromium can be deposited over a wide range of solution concentrations and operating temperatures it practice the operating conditions are held within quite closely defined limits. This is

Runkouski and Knorr[1] have measured the deposition potentials at chromium surfaces and have suggested that the deposition of chromium from the hexavalent ion takes place in four steps, the final stage being a reduction of divalent chromium to chromium metal. This confirms the work of Birynknov[2] in 1941 and Ogburn and Brenner[3]

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ONE might have expected that with the vast amount of out-doors all around us, and seeing what happens to finishes when they are exposed to it for long almost anywhere, there would not be much difficulty in performing outdoor exposure tests. Yet finding the right kind of outdoors for such tests seems to be quite a problem and many organizations are prepared to go quite a long way for it. The British Non-Ferrous Metals Research Association likes Chichester, one of the largest of our paint manufacturers, located in the Home Counties, goes all the way to Torbay, and a motor accessory firm finds that Brighton disagrees with its chromium plating more than its native Midlands.

However, the most important location for the exposure testing of finishes is undoubtedly the south-eastern seaboard of the U.S.A. where more corrosion test stations flourish than anywhere else. In Florida the General Motors Corporation station covers ten acres and can deal with 2,000 samples a month, which are sent there from its subsidiaries all over the world, including the United Kingdom. Some 5,000 test panels are tested in the open, and a great many samples of materials used for the interior fittings of motor cars are exposed under glass. In North Carolina, at Kure Beach, the International Nickel Company has the world's most extensive corrosion research facilities, which has room for subjecting 28,000 specimens to atmospheric tests, and also racks for sea water immersion.

Not far away, there is also a commercial testing establishment which offers an independent evaluation service on samples and materials submitted to it.

One remarkable thing about exposure test stations is that they are usually in salubrious locations, far from the industrial centres where most of the products to be tested are made, or for that matter, used.

ELECTRICITY PIPES

THE main object of the heavy bus bars used in plating equipment is to ensure that overheating does not occur. If this could be reduced much of the excess weight of copper (or aluminium) could be eliminated with a substantial capital saving. It is interesting to see, therefore, that the dimensions of the copper cable used in the new cyclotron at Glasgow University are kept small by water cooling through a central duct; the strands of cable which surround this duct are insulated with polythene.

Water cooling is being used to an increasing extent for rectifiers in electroplating, so there seems no good reason why water-cooled bus bars should not be employed also, particularly as the water could then be used in rinse tanks. The cost of putting water channels in the bus bars should be quite small.

This raises the further possibility of combining the water and electricity services by supplying the rinse tanks through heavy gauge copper pipes which would themselves be used as the bus bars for the low voltage current supply. In this way the amount of metal used could be substantially reduced and cooling obtained at the same time. To the best of my knowledge this has never been done before but there seems to be no valid reason why it should not be practicable in some installations

ANODIC ARTISTRY

TO the artistically inclined, the lead anode used in chromium plating presents a constant challenge. Originally it was simply a flat strip of lead, but nowadays the user has an embarrassing choice of designs. In this country there is the round rod or bar as an alternative, and also the corrugated type.

One American company offers a choice of four anodes, *viz.*, flat, round, saw tooth and super saw tooth. The saw tooth is serrated on both faces, with a flat surface in the middle of one of them. The super saw tooth is the same as the saw tooth but bigger. It is interesting that this manufacturer makes no claim for the relative merits of any of these designs, leaving the choice to the wisdom—or prejudice—of the customer.

In Canada, a hollow lead anode is now available which saves weight and money although, clearly, the conductivity is reduced. Whether this matters or not is also a subject of controversy, since another manufacturer puts a copper core in his anodes to improve conductivity.

It is, of course, extremely difficult to prove anything about the relative merits of these different designs; the problem is to distinguish between mere novelty and technical superiority.

Recent Developments in CHROMIUM PLATING‡

by D. E. WEIMER*

CHROMIUM deposition is principally carried out from chromic acid solutions containing small percentages of catalysing ions. While chromium can be deposited over a wide range of solution concentrations and operating temperatures in practice the operating conditions are held within quite closely defined limits. This is necessary in order to deposit the metal in a way acceptable industrially.

Until recently in this country it has been the practice to chromium plate in chromic acid solutions of two ranges namely 200-250 gm. per l and 350-450 gm. per l. The principal reasons for this are that deposits of the highest hardness, and the highest deposition efficiencies, are obtained from solutions in the lower concentration range which are therefore suitable for thick or hard chromium deposition. Solutions in the higher concentration range on the other hand are more tolerant of impurities and changes in solution composition and are more suitable for decorative plating. In America and to some extent on the Continent this practice has not been followed as it is considered that the easier operation of the high concentration baths for decorative application is more than compensated for by the lower make-up cost and lower maintainance costs of the dilute solutions. The development of the dilute self-regulating type of solution (S.R.H.S.) the principles of which will be discussed later, has further weakened the case for the concentrated solutions for decorative use. The advantages of the S.R.H.S. solution are the high speed of plating, the ability to "chrome onto chrome," good covering power, and solution stability under variable operating conditions.

Factors Influencing Chromium Deposition

The mechanism of the electro-deposition of chromium has provided research workers with a baffling problem. It is not proposed here to discuss critically the many hypotheses which have been advanced but rather to draw attention to new work on the subject.

Runkouski and Knorr[1] have measured the deposition potentials at chromium surfaces and have suggested that the deposition of chromium from the hexavalent ion takes place in four steps, the final stage being a reduction of divalent chromium to chromium metal. This confirms the work of Birynknov[2] in 1941 and Ogburn and Brenner[3] somewhat more recently. The function of sulphate and other foreign ions in chromium deposition has been the subject of much speculation, although most research workers have postulated the presence of some form of complex being present. More recent work by Froy and Knoor[4] has tended to confirm this. They suggest that the reason why deposition will not take place from a solution without a catalyst is that a film of trivalent chromium forms over the cathode allowing only hydrogen to be evolved. The presence of sulphate for example enables penetration of this film to take place. Some sulphate is suggested to be in the form of a complex since the addition of barium chloride will not precipitate all the sulphate present in a solution. The deposition mechanism is attributed to the free sulphate, because the chromium deposition ceases after a while when the cathode is contained within a diaphragm. It is suggested that all the free sulphate within the diaphragm has been complexed and thus deposition is inhibited. It is suggested that the sulphate complex is broken down at the anode.

Some interesting experimental work was recently carried out by Brittain and Smith.[5] They continuously observed and photographed at high magnification the surface of a cathode on to which chromium was being deposited. The work showed that the release of hydrogen bubbles from the surface was a discontinuous process occurring with a definite periodicity. Periodic cracking at the surface of the cathode was observed and was found to be associated with the discontinuous evolution of hydrogen.

The practical man is not so much interested with the electro-chemistry of the plating process, but rather how these complex reactions can be regulated to produce satisfactory deposits. There

*M. L. Alkan Ltd.

‡This article is based on a lecture, which was one of a series on "Recent Developments in Metal Finishing" held at the Borough Polytechnic, London.

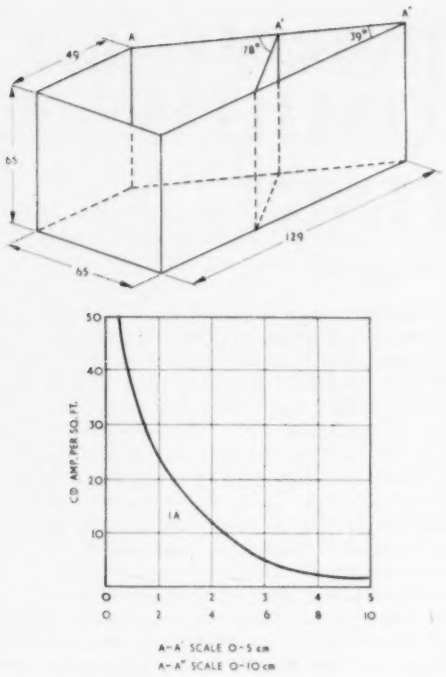


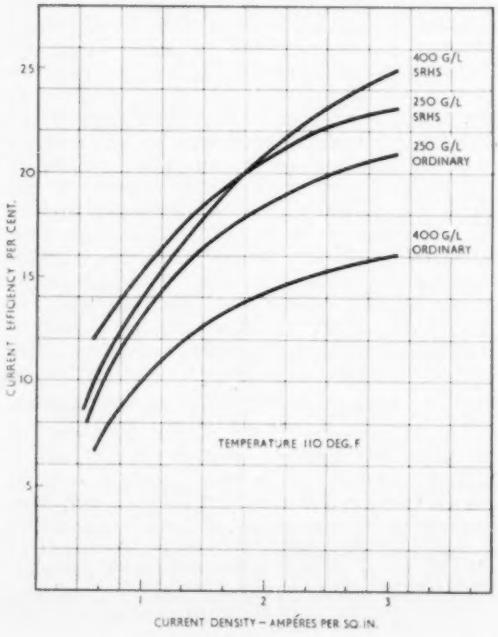
Fig. 1.—Sketch of Rousselot Cell and current distribution diagram.

are five major factors influencing chromium deposition, namely, chromic-acid concentration, chromic acid to catalyst ratio, solution temperature, current density, concentration of impurities. All these factors influence the bright plating range and covering power of the chromium solution. It has been shown by Rousselot[6] that there is an optimum relationship between these factors. He used the standard Hull Cell for his experiments but instead of depositing on the standard flat test panel in the conventional way he bent the panel in half to an angle of 78° and then placed it in the Cell as shown in *Fig.* 1. He determined covering power by measuring the depth of penetration of the chromium into the bend under controlled plating conditions. He was able to show that at any one temperature and chromic acid concentration there was an optimum sulphuric acid concentration to produce the maximum covering power. In the same way he determined the effect of impurities such as trivalent chromium and iron on covering power. He was able to show quantitatively the less critical nature of the high concentration solution to changes in chromic acid to sulphate ratio ; and he finally came to the conclusion that baths of intermediate chromic acid concentration were better technically for decorative plating than those conventionally used. The results of his findings were investigated on a production scale and found to be substantially sound.[7]

However Rousselot's method has not been used extensively in this country and the choice of plating conditions are still chosen empirically. Conditions are more easily standardised when plating relatively simple shapes, for example bumper bars and over-riders, but more difficult when plating complicatedly shaped zinc base die-castings. The plating of these can generally be simplified by jigging and "self-robbing" of high current density areas for example, but when plating many differently shaped parts considerable difficulties are often experienced when trying to plate under standardized conditions. In fact decorative chromium plating on a large scale demands a compromise between what is desired and what can be readily achieved in the nature of covering and throwing power.

Without the presence of a catalyst no deposition of chromium will occur from a chromic-acid solution. This general term of catalyst is used today with reference to chromium-plating solutions, because so many compounds other than sulphuric acid have been shown to bring about chromium

Fig. 2.—Comparative cathode efficiencies between ordinary and S.R.H.S. chromium solutions.



deposition. The most common single catalyst being used is still the sulphate anion and it has been found desirable to maintain a smaller percentage of this radicle in solutions containing other radicles such as fluoride, silicofluoride and fluoborate. The total percentage of catalyst used is approximately 1 per cent by weight of the chromic acid concentration. The advantages of the other acid radicles over the single sulphate ion are increased current efficiency (*see Fig.* 2) and improved bright plating ranges.

One of the biggest problems in the operation of a two-catalyst solution is the control of the individual catalysts, each requiring separate analyses. In the case of the ordinary bath there are only two main solution variables, namely the chromic acid and sulphate concentrations. In the two-catalyst solution there are three, the implications of which can be readily appreciated, since an alteration in the concentration of one means an independent adjustment of the other two. This is further complicated by the fact that silicofluoride or fluoborate cannot be readily removed from solution in the same way as sulphate can by the addition of a barium compound. Fortunately this problem has been overcome by the introduction of the self-regulating solution. In this bath the catalysts are added in the form of sparingly soluble salts, an excess of which is always lying insoluble at the bottom of the plating tank. Alterations in temperature or chromic acid concentration of the solution cause a re-adjustment of concentration of catalyst salts in solution either by a precipitation or dissolving of residual catalyst. A daily hoeing up of the residue ensures that it does not become " blanketed " by lead chromate which has settled to the bottom of the tank and thus prevent solution equilibrium being maintained. The principle of self regulation enables the more exacting dilute chromic acid solution to be used without difficulty.

The presence of ions other than the catalyst acids adversely effects the deposition characteristics of a chromium-plating solution. The exception is trivalent chromium which in small amounts, *i.e.* less than 1 gm. per l. assists in reducing the critical nature of the chromic acid to catalyst ratio with respect to covering power.

Heavy metal impurities individually and at low concentration have little detrimental effect but the additive effects of small concentrations of a number of these metals will certainly reduce covering power. This is probably due to the reduction in concentration of " free " chromic acid, thereby altering the actual chromic acid to catalyst ratio. Iron is often a contaminant in hard chromium plating solutions but up to 6 gm. per l. can be tolerated without any significant change in plating characteristics. Borates and chlorides are common impurities in decorative chromium plating solutions. The former is only significantly harmful in fluoride-containing solutions and even then only in concentrations in excess of a few grams per litre. Chloride is harmful in all types of solution even at a concentration of .05 gm. per l. It gives rise to loss of efficiency, reduction in covering power and etching of the bare metal at low current density areas. In addition it causes an increase in usage of anodes and nodularity in hard chromium deposition.

Spray Suppressants

One of the most readily accepted recent developments is the use of spray suppressants in decorative chromium plating solutions. It has already been approved by the Factory Inspectorate as an alternative to fume extraction. Another advantage of spray suppression is the keeping of bus-bars, tops of plating suspenders and racks free from chromic acid thus minimizing corrosion and further preventing contamination of adjacent solutions. Considerable financial savings are claimed by the reduction of drag-out losses. This however only applies to articles which do not have deep recesses etc., when drag-out losses due to " cupping " of solution far outweigh losses due to surface tension effects. These addition agents are unsuitable for hard chrome giving rise to pitting.

They are quite costly to purchase and a close study of the quantitites used and their effect on the chromic-acid consumption is necessary before any conclusions can be drawn as to their economic advantage in a particular plant.

The most important factor which has to be determined is the amount of spray suppressant required to remove the necessity of an exhaust system. To use a reduced amount of spray suppressant in conjunction with the extraction system is false economy, since under these conditions a proportion of this expensive material is removed by the extraction. Temperature of operation is another factor which seriously influences the economics of spray suppression. Some materials decompose at the higher temperatures now used in decorative chromium plating. This decomposition is also effected by the composition of the electrolyte. Suitable materials for all temperatures and all types of solutions are now available and the recommendations of the supplies should be followed in this respect.

Anodes

A very important aspect of chromium plating which is often taken for granted and therefore neglected is the function and nature of the anodes to be used. Unlike the majority of plating pro-

cesses the anodes used in chromium plating do not replace the metal used in deposition. It has been found impracticable to use wrought chromium anodes and the use of lead or lead alloy anodes is recommended. The anode, on electrolysis, forms a peroxide film which protects it from chemical attack by the solution, but when not being electrolysed this film dissolves in the solution as does the underlying metal. In order to minimize the corrosion of the anode, various metals have been alloyed with it and for conventional solutions up to 7 per cent antimony has been found satisfactory in increasing the life of the anode. Various other alloying metals have been investigated including silver, tellurium and tin, 5 to 7 per cent of the latter being considered better than antimony in fluoride-containing solutions. A new lead, Antimony, silver alloy has been developed which is claimed to be superior to all other lead-based alloys both for tank linings and for anodes.

Whilst the primary reason for anodes in a chromium-plating solution is a means of passing current through the solution, the need for ensuring that the anodes are functioning properly, *i.e.* that the anode is correctly filmed over its whole surface and is carefully positioned in relation to the work being plated cannot be over-emphasised. Without attention to these details, current distribution on the work will suffer and poor covering and throwing power will result. Anodes should be regularly maintained to ensure that the surfaces are free from salt encrustations below the solution surface. It is not enough to watch the anode apparently gassing freely at the surface. The anodes should be withdrawn completely every day and examined for breaks in the anode film. One other important function of the anodes in a chromium-plating solution is the control of the amount of trivalent chromium present in the solution. Without a small amount of this impurity the chromic acid to sulphate is very critical with respect to covering power. The trivalent chromium can be regulated by the current density on the anode. Low anode current densities tend to reduce the formation of trivalent chromium.

The troubles experienced in chromium plating due to anodes is certainly not entirely the users fault as the suppliers have often sold anodes not adequate for the job. This is mainly a question of design and in recent years some considerable attempt has been made to overcome these problems.

The earliest anodes were merely lead sheets, pierced at the top through which were put iron hooks suspended from the anode rail, and undoubtedly many chromium plating troubles were due to this arrangement. The next logical development was the casting of a slab of lead or lead alloy around a copper hook. The main problem was the lack of adhesion between hook and anode,

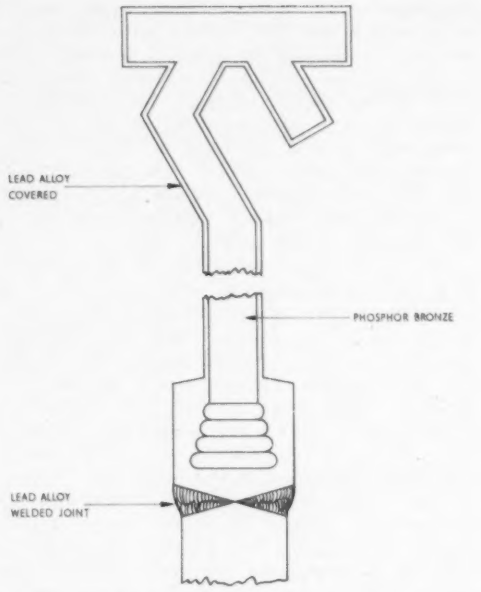


Fig. 3.—*Sketch of prefered anode hook design for chromium plating anodes.*

giving the anode a high internal resistance. The stem of the copper hook was next extended down the complete length of the anode to try and improve current distribution, but the disadvantages of such a system were greater than for the smaller hook, because if the cast anode was porous chemical and electrolytic attack on the copper ensued. Aluminium was next used for the conductive core, and while this minimized electrolytic attack through a porous lead casting, when idling, the core was still attacked chemically. It does seem preferable to keep the hook section above the solution level. Probably the best type of anode is of circular section, made from extruded tin-lead alloy and burnt onto a heavily lead alloy covered short copper hook at an inverted cone joint thus ensuring it is always above the solution level. (*Fig* 3).

Tanks

A great majority of chromium-plating tanks in this country are water-jacketed steel tanks lined with a 7 per cent antimony-lead alloy at a weight of 8lb. per sq. ft. Tin lead alloys are also being used for the fluoride-type solutions. It has been suggested that this material is more difficult to weld than antimonial lead and since there has been no trouble in using this latter material with fluoride-type solutions, the tin-lead alloy is not used to any considerable extent. It is

interesting to note however that the tin-lead alloy is used exclusively for anodes in fluoride-containing chromium plating solutions.

There is still a considerable variance in opinion as to how a new tank should be treated, if at all, before chromium plating is commenced. There are advocates for maintining the tank at a positive potential at all times to ensure that a protective anodic film is always present on the lining. Others favour a short period of electrolysis of the solution initially with the tank being made the positive pole, after which every step is taken to ensure the tank lining is kept electrically neutral by insulation with glass linings etc. This method has produced very few, it any, lining failures due to electrolytic action.

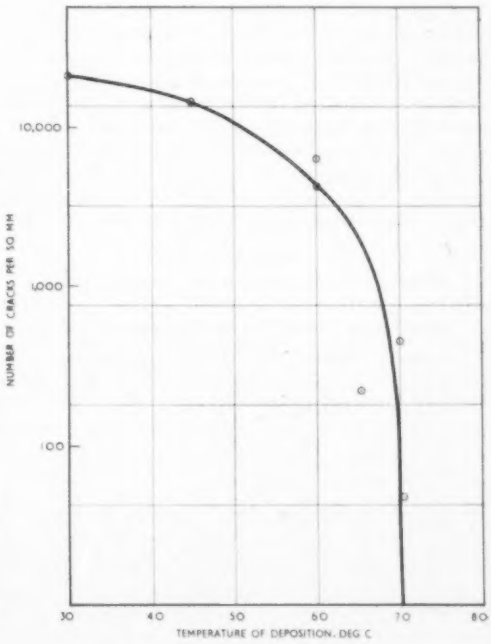
The general use of plastics for chromium plating tanks has not taken place in this country as it has in America. The reason for this is undoubtedly the limitations of the chemical resistance of PVC particularly bearing in mind the considerable volume of high-concentration chromic-acid solutions still used in this country for decorative plating. Further, the technique of fabricating tanks by lining them with PVC sheets has often been faulty in that the welding was poor and the linings often fractured along the welds particularly when the tanks were water-jacketed and subject to thermal shock. Improvements in welding technique have been made and with the introduction of spray plastisols, fabrication difficulties have been reduced so that in a year or two perhaps PVC will be used generally in the plating industry in this country.

Chromium Plating in Automatic Machines

Another aspect of chromium plating on which there has been little comment in recent years is the problems associated with chromium deposition in some form of automatic plating machine. Chromium plating is carried out in three types of machines consisting of the "returning type" rotomatic, the "straight through" in-line machine and the fully automatic machine in which the chromium plating is the last of many plating operations. The operation of the rotamatic is fairly fool-proof, the work is pretreated as if for vat-plating and then it is placed on a moving arm the mechanism of which can be so adjusted to alter the time taken for the parts to return to the original place of entry. There are no great difficulties in operating such a machine. The work is hand fed and provided that care is shown in ensuring a "positive" contact between jig and carrier bar initially, no special troubles should be experienced. Inadequate cleaning of anode bars and servicing of anodes however can lead to trouble since poor covering power, as has already been stated, can result from faulty operation of anodes. The main limitation of such a plant is the relatively small size of work which can be handled since the parts must pass through and around a relatively small circle in order to be in the loading-unloading position in a matter of 3-5 minutes, the normal plating time required. The inline type of machine can be used for all types of work but of course at least two operators are required. Inflexibility of time cycle is often a disadvantage with this type of plant.

The major problems of fully automatic plating machines are carry-over from proceeding processes, drag-out losses and lack of flexibility. It would seem that rinsing facilities between nickel and chromium are always at a minimum which often gives trouble with "cupped" shaped articles Quite often little consideration has been given as to whether the work should enter the chromium solution with the current on or not, and the current available is often well below that required for deposits in excess of .00001 in. minimum thickness. The time cycle is always dependent on the other plating operations. The current supply is often inadequate to ensure initial cover on complicated parts without reducing the significant area per jig. Due to plant design daily servicing of anodes in

Fig. 4.—Showing effect of plating temperature on frequency of cracks.



the chromium bath is often difficult if not impossible without a major "shut down". With the move towards automation in plating it would seem that a more realistic approach is required for chromium plating. It would seem highly desirable in the future to plan for seperate chromium, nickel and copper plating machines in order to give greater flexibility to the plating operations thus enabling relatively simple modifications to be made to take advantage of any new plating developments, that might occur during the potential life of the machine.

Physical Properties of Chromium

So far the chromium plating solutions and the factors which influence the production of satisfactory deposits, have been discussed but little has been said about the deposits themselves.

The general properties of electro-deposited chromium have been continually investigated and in recent times it would appear that these investigations have been intensified, particularly with respect to the nature of stress and its effect on the fatigue properties of the underlying bare metal. There seems to be general agreement that the fatigue limit of chromium-plated steel is independent of the hardness of the steel base and is a function of the residual internal stress of the chromium and the intrinsic fatigue strength of the electrodeposit. It is suggested that the fatigue limit of normal hard chromium is between 20-25 per sq. in., and that the fatigue limit of "as plated" chromium-plated steel is largely independent of the deposit thickness. By the heating of some plated steels to temperatures around 520°C it is possible to restore the fatigue limit to that of the plated steel, although only with some loss in hardness of the chromium deposit. (Table I). Recent patents in America have claimed that special solutions will ensure at least 85 per cent retention of the fatigue strength of the base metal after low temperature heat treatment. The

Table I.

Effect of heat-treatment on hardness of Cr

Self-regulating Solution		Government data (D.T.D.916A)	
Temperature	Hardness V.P.N.	Temperature	Hardness V.P.N.
Room	960	Room	800 - 900
100°C	920	—	
200°C	835	—	
300°C	825	—	
400°C	820	400°C	650
500°C	810	500°C	600
600°C	640	600°C	420
700°C	550	700°C	300
800°C	440	800°C	250

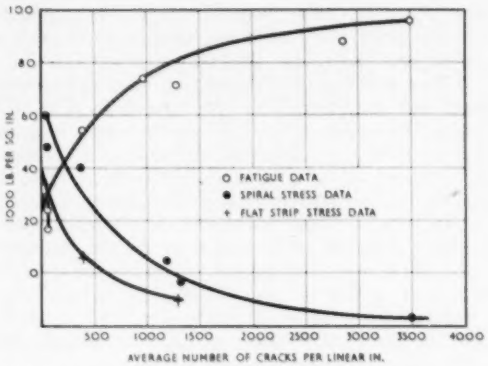


Fig. 5.—Showing relationship between crack pattern and other deposit properties of chromium. (Starack et al).

relationship between crack pattern and other deposit properties can be seen from Fig. 5. Fry[8] in an extensive study of crack pattern came to the conclusion that striations parallel to the base metal and shown up by etching the cross-section of a deposit are associated with cracked chromium deposits. Striations become wider and crack depths increase but the number of cracks decrease as the plating temperature is raised (*Fig.* 4). Cracks and striations disappear at a temperature of about 160°F.

Fry further concluded that in uncracked deposits, stress is independent of, or decreases, with deposit thickness. Cracking is not therefore due to stress increasing with thickness until the tensile strength of the deposit is exceeded. He observed that isolated cracks occur before general cracking sets in and that at approximately the thickness at which general cracking occurs, the first striation is formed and mean stress begins to decrease rapidly. In his work Fry used a 250 gm. per l. chromic-acid solution and a 100 : 1 chromic acid to sulphuric acid ratio; and the maximum thicknesses for crack-free chromium deposits are given in Table II. One comment on this work might be that the thicknesses at which cracking occurs differs from that normally observed in accelerated or outdoor corrosion tests, *i.e.* 0.00002 in. Although this fact was not brought out in this paper Fry[9] confirms that observation. There seems little doubt that a corrosive atmosphere initiates cracking where none exists when the metal is deposited.

It was generally considered until recently that in decorative chromium plating it was the nickel, and to a far less extent the copper, undercoat, which provided the protective film over the base metal, the chromium layer being purely a tarnish-resistant film deposited to prevent the unsightly oxide forming on the nickel undercoat.

Table II

Effect of temperature on maximum chromium thickness which is crack free (Fry's method).

Temperature °C	Current Density amp/dm²	Maximum Thickness for Crack Free Deposits (Microns)	
40	16	>2.5	<3.5
	30	>1.5	<15
50	10	>1.2	<2.5
	30	>3	<6
	64	>4	<8
65	30	>30	
	40	>10	
	64	>14	<24
	80	>1.5	

The corrosion resistance of the nickel was found to be nearly directly proportional to its thickness and it was considered that this was due to a reduction in inherent porosity of the nickel as the thickness was increased (*Fig.* 6). The factors influencing this porosity were taken as being the surface condition of the basis metal, cleaning procedures prior to plating, and the condition of the nickel solution from which the deposits are plated. However, it has now been shown that atmospheric attack on the deposited metal at selected sites is probably the main cause of failure in nickel deposits. Initially the attack must occur at pores or cracks in the chromium deposit. It is well known that chromium is quite porous up to thicknesses of 0.00002 in. and over that thickness, it readily cracks on outdoor exposure. Thus it can be seen that the production of crack-free and pore-free chromium would increase the service life of nickel-chromium deposits and perhaps to a far greater extent than could be imagined from the thicknesses of chromium proposed. It has also been recently suggested[10] that bright nickel deposits may be subject to stress cracking due to the liberation of atomic hydrogen at the surface during the initial stages of chromium deposition. These cracks, it is proposed, account for the poor corrosion resistance of some bright nickel coatings in comparison with polished dull nickel when chromium plated. A crack-free chromium deposit may give better protection.

In the field of engineering the need often arises for a suitable finish which is required to have both wear and corrosion resistant characteristics. A heavy nickel deposit falls within this category although a thickness of a few thousandths of an inch which would be necessary, may be outside the dimension tolerance limits for a particular part. Hard chromium is not always suitable if the corrosion conditions are severe, while a few ten-thousadnths of an inch of cadmium would often be satisfactory from a corrosion point of view but its wear resistance would be unsuitable. A thin crack-free, pore-free, chromium deposit would be the answer to this problem.

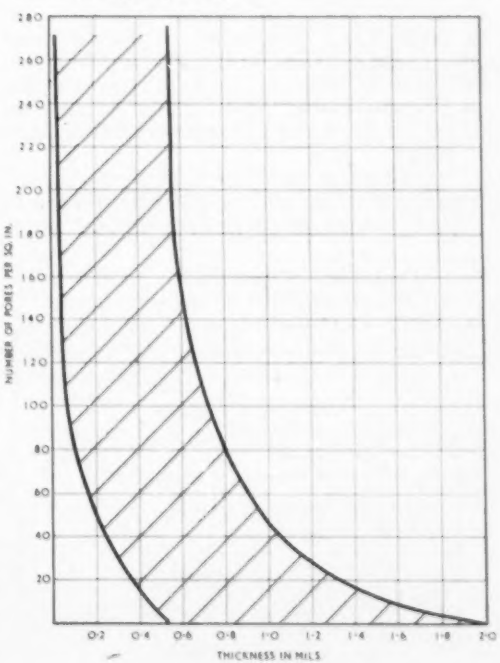
The practical difficulties of producing relatively thick crack-free deposits at high temperatures from conventional solutions has limited their commerical application. The high temperature of operation necessitates special solution-heating methods, while the solution has a poor covering power and a low plating efficiency, all of which factors leading to high operating costs.

However commercially practical solutions have been developed to produce crack-free deposits both for the decorative and engineering fields, the dividing line in application being related to the brightness and thickness of the crack-free deposit as will now be discussed :—

Bright Crack Free Deposits

The production of bright crack-free deposits from conventional solutions is certainly not so difficult as the production of the thicker deposits suitable for engineering purposes and only recently Brown[11] and others have shown that bright crack-free chromium deposits can be

Fig. 6.—*Results of conventional porosity tests on nickel coatings. (Wesley).*



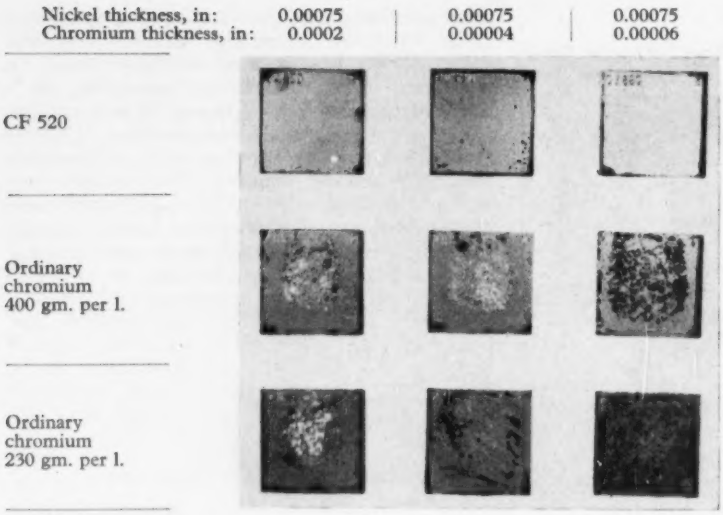
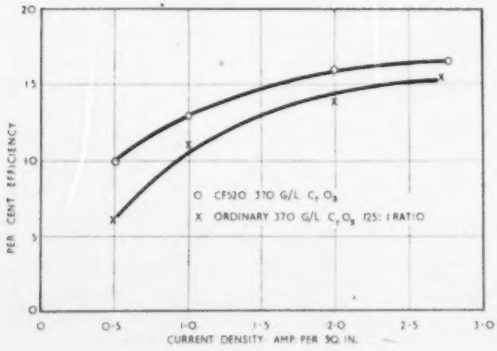


Fig. 8.—Comparative SO_2 corrosion results on bright nickel/chromium plated steel.

obtained from the 250 gm. per l. chromic-acid bath using a 150/200 : 1 ratio of chromic acid to sulphuric acid at an operating temperature of 130°F and an average current density of 1 amp per sq. in. These conditions are of course somewhat outside these normally used for decorative chrome-plating and the adoption of such techniques would require quite considerable modification of existing plant and jigging techniques. At the 1957 A.E.S. Convention a more practical solutio 1 was proposed *i.e.* one that could be used with existing plating equipment and yet still produce the desired results. This process was the subject of a recent investigation in the author's laboratory.

The solution is based on a chromic acid concentration of 375 gm. per l. As with the well-known S.R.H.S. process the catalysts are in the form of sparingly soluble salts and in this way the balance of the solution is self-regulated with respect to the catalysts, at varying chromic acid concentrations and temperature changes. The recommended operating temperature is 115°F to 120° and the average current density range from ½ to 2 amp. per sq. in. The solution has excellent covering power, and thicknesses of 0.000006 in. per minute can be obtained at 1 amp. per sq. in. The plating efficiency is shown in Fig. 7.

Fig. 7.—Comparative cathode efficiencies of CF520 (crack-free) and ordinary solutions at 120°F.



Investigations were carried out in order to assess whether crack-free deposits were readily obtained over the wide range of operating conditions recommended and to assess the influence of impurities and spray suppressants which are so commonly present in decorative solutions. In addition specimens were plated from the 400 gm. per l. and 250 gm. per l. ordinary chromic-acid baths using a 100 : 1 ratio as well as the standard S.R.H.S. solution in order to compare the results with those obtained from the crack-freebath [12] (henceforth designated as CF520[12]). It was decided to assess the quality of the deposits by means of a modified sulphur dioxide test, the test results from which had compared favourably with those obtained from the more conventional sulphur dioxide cabinet. The sulphur dioxide test[14] seems to be particularly suitable for showing up defects in the chromium deposit.

The results can be briefly summarized as follows :

The two orthodox solutions and the S.R.H.S solution produced crack deposits at approximately 0.00002 in. and above. In the case of the CF520 solution no cracking occured until the operating temperature was reduced to 110°F and then only at a current density of 2 amp. per sq. in. and a

thickness of 0.00004 in. Concentrations of chloride below 0.05 gm. per l. and boric acid below 3 gm. per l. did not effect the crack-freeness of the deposit. A number of spray suppressants were also tested with no apparent adverse effects although only materials stable at high temperatures and in the presence of fluorides were investigated. The comparative results obtained between the different solutions can be seen in Fig. 8. The test panels were plated in a special jig to minimize current density variations across the test panel. Only the centre square inch represents the thickness of deposit stated. Elsewhere the deposit is thinner or non-existent.

In addition to the test panel work, standard components were plated in a 50-gallon bath and put under test in various laboratories and in all cases the deposits from the CF520 solution have given superior corrosion protection to those plated with conventional chromium. In the last year a good number of production tanks have been installed.

The improved corrosion resistance obtained from these deposits is dependent on thickness. Deposits below 0.000015 in. are quite porous while above this thickness porosity decreases and the corrosion resistance increases unlike the deposits from the orthodox solution. At thicknesses in excess of 0.0001 in. however cracking occurs and the corrosion resistance does decrease. The average thickness which can be deposited depends very much therefore on the shape of the article being plated. Production experience indicates that 0.000035 in. is a reasonable average thickness to obtain maximum corrosion resistance.

In present day practice, lower average thicknesses are being plated but results show that crack-free chromium still offers advantages in high-current-density areas where cracking often occurs with the orthodox solution.

Crack Free Deposits for Engineering Applications

It has been found impractical to produce crack-free deposits from conventional solutions unless the operating temperature is raised above 160°F. A solution has recently been patented[13] in which selenium compounds are added to a conventional chromic-acid solution which enables crack-free deposits to be deposited to up .001 in. at temperatures only slightly above (120°F) those normally used for decorative plating. However the deposits are dull and the solution has poor covering power thus severely limiting its application particularly in the decorative field. By further modifications of the basic chromic-acid solution it is possible to produce a solution with adequate covering power and plating speed although the operating temperature is still rather high (150°F). This solution will produce crack-free deposits up to 0.001 in. thickness. The presence of chloride is liable to cause cracks and this anion must be kept below 0.03 gm. per l.

These latter crack-free deposits are generally softer than those obtained from the conventional chromium solutions, the hardness being in the order of 600 V.P.N.

It has found application in the electroplating of spoon dies where the relatively soft deposit, unlike ordinary chromium, contributes to a longer die life due to the anti-galling properties of the deposit. It has been shown that a matter of 0.0003 in. of crack-free chromium increases " die life " in the forming of nickel-silver spoons by as much as 400 per cent. Further applications of the deposit are in the protection of washing machine parts, hydraulic rams and other components where wear and corrosion resistance are required at the same time. High temperature oxidation can also be satisfactorily prevented without mechanical loss in strength of the component.

Conclusions

In the last five years considerable advances have taken place in the technology of chromium plating and these can be summarized as follows :—

(a) A fuller understanding of the effect of heat treatment on the physical properties of chromium.
(b) An appreciation of the nature and mode of formation of cracks in chromium.
(c) The acceptance of spray suppressants as a replacement for fume extraction.
(d) The increased commercial application of high speed solutions.
(e) A complete appreciation of the practiability of self-regulation of catalysts in chromium solutions.
(f) The installation of the first commercially operated solutions for the production of crack-free chromium.

Acknowledgements

The author would like to thank Mr. B. Lugg for preparing the drawings and graphs used in this article and also acknowledge the permission of the directors of M. L. Alkan Ltd, to publish.

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GALVANIZED SHEET FOR OUTDOOR APPLICATIONS

by M. H. DAVIES*

Introduction

HOT-DIP galvanizing is still one of the best and cheapest methods of protecting steel, and galvanized sheet, corrugated or flat, has long been used as a building material. In the past however, users have paid relatively little attention to variations in the quality of coated sheet (particularly the coating thickness) and, in addition little consideration has been given to maintenance. A hot dip galvanized coating will prevent rust for many years, particularly in unpolluted atmospheres, but it would be wrong to expect an indefinite life from galvanized steel sheet, probably the cheapest basic building material, without some attention to maintenance.

The life of a galvanized coating is proportional to its thickness and it is, therefore, important to ensure that the sheet or strip has a coating of adequate thickness for the application involved. Present day production techniques in the sheet and strip galvanizing industries permit control of the galvanized coating thickness. The highest degree of formability demands relatively thin coatings whose corrosion resistance will necessarily be lower than the more heavily coated sheet and the purpose of this note is to guide users and potential users on the performance to be expected from galvanized sheet. Due regard to the quality of the coated sheet and to proper maintenance when necessary, will not only result in considerable savings but also in an indefinite life for the sheet.

British Standards for Galvanized Sheet

Recently, two British Standards have appeared describing the grades of hot-dip galvanized sheet and strip which are currently being manufactured. B.S. 3083:1959 entitled "Hot-Dip Galvanized Corrugated Steel Sheets for General Purposes" describes four grades of coated sheet and these are given below in Table I.

Because of the relationship between coating thickness and life it is apparent that the coating on type 200 material will last nearly twice as long as type 125 exposed under similar conditions.

A high proportion of galvanized sheet is now manufactured by continuous processes. B.S. 2989:1958 entitled "Continuously Hot Dip Galvanized Plain Steel Sheet and Coil" describes six classes, details of which are given below :—

Class A : having a zinc coating of 2 to 2.5 oz. per sq. ft. including both sides.

Class B : having a zinc coating of 1.8 to under 2 oz. per sq. ft. including both sides.

Class C : having a zinc coating of 1.5 to under 1.8 oz. per sq. ft. including both sides.

Class D : which is intended for general use but not for severe bending or forming and which usually possesses a zinc coating of 1.1 to under 1.5 oz. per sq. ft. including both sides.

Class E : working up quality which can be folded through 180 deg. over two pieces of material of the same thickness without flaking of the zinc coating.

Class F : a special tight coat working up quality which can be folded flat on itself without flaking of the zinc coating.

It is recommended that the purpose for which continuously galvanized strip is intended should be disclosed to the manufacturer so that he may supply a quality with adequate corrosion resistance for harsh conditions, or, alternatively, a coating

Table I.

Coating weight of hot dip galvanized steel sheet (from B.S. 3083).

Type	Weight of zinc coating oz. per sq. ft. (including both sides)**	
	Minimum	Maximum
125	1.25	1.49
150	1.50	1.79
180	1.80	1.99
200	2.00	2.50

** *Note.*—In general or jobbing galvanizing practice it is usual to express the coating weight in terms of oz./sq. ft. of surface whereas for coated sheet it is conventional to express the coating weight in oz./sq. ft. of sheet. The figures quoted for coating weights on sheet must therefore be halved in order to obtain the equivalent thickness per unit surface area or to compare directly with the coating weights associated with fabricated articles or structures which are hot dip galvanized.

*Zinc Development Association, 34 Berkeley Square, London, W.1.

Table II.

The life of galvanized sheet.

Site	Coating Weight (oz. per sq. ft. including both sides)						Unprotected steel
	2½			1½			
	Years to first appearance of rust	Years to 100% rust	Years to first perforation, any sample	Years to first appearance of rust	Years to 100% rust	Years to first perforation, any sample	Years to first perforation, any sample
(1) Severe Industrial[1]	5.9 average	14.4 average	19.5	3.2 average	6.1 average	15.5	2.0
(2) Severe Industrial[2]	4.6 average	11.2 average	17.5	2.4 average	4.3 average	13.5	4.3
(3) Rural[2]	20.5 minimum	none after 32 years	none after 32 years	14.6 average	29.0 minimum	none after 32 years	24
(4) Atlantic Coast Marine[4]	13.1 average	23 minimum	none after 25 years	6.8 average	15.2 average	none after 25 years	4.9
(5) Rural Marine[3]	spots in 19.8 minimum	—	21.5 minimum	spots in 10.6	—	14.8	3.6

[1] 1952 Report, [2] 1954 Report, [3] 1958 Report of Subcommittee XIV of the A.S.T.M. Committee A5 on Corrosion of Iron and Steel.

which will not flake upon severe fabrication. The thin coatings are designed for applications where good fabricating properties are required Where Where such applications involve continuous outdoor exposure, particularly in polluted atmosphere, long term protection can be obtained by painting and regular maintenance.

The advantages of the zinc coating beneath the paint are many. Paint durability is increased, maintenance simplified, and maintenance costs reduced. The paint itself preserves the zinc coating for its essential function of preventing rust. These advantages are reflected in B.S. P.D. 420* which describes a thick zinc coating (0.0025 in.) plus a two-coat paint system as a grade 1 protective scheme suitable for severe outdoor exposure.

†British Standards Institute P.D. 420 Sept. 1953. Methods of Protection against Corrosion for Light Gauge Steel.

Life of Galvanized Sheet

The American Society for the Testing of Materials has been responsible for conducting extensive tests on the performance of galvanized sheet, and Table II demonstrates clearly the benefits to be obtained from a zinc coating. The figures are taken from various reports issued by the committee on corrosion of iron and steel and apply to coated sheet specimens 26 x 30 x 0.0336 in.

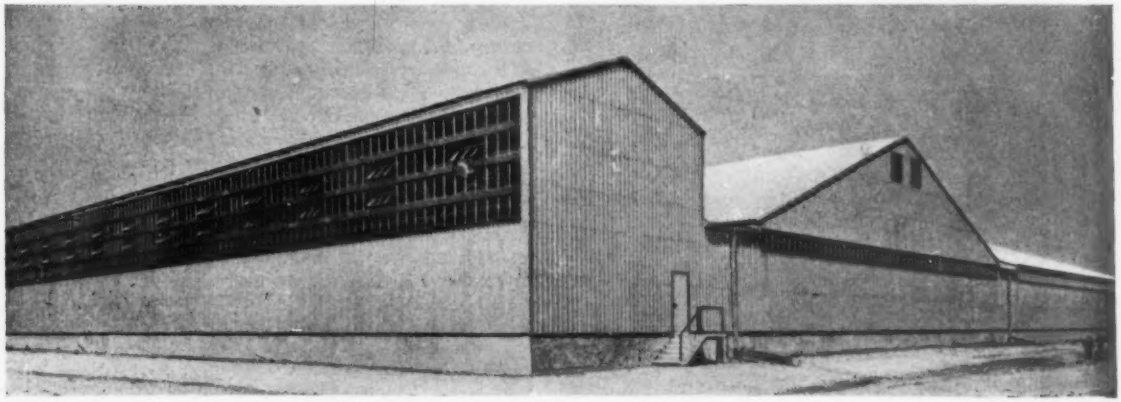
The types of atmosphere represented in Table II are :

(1) Severe industrial	Brunot Island, Pittsburg, Pa.
(2) Severe industrial	Altoona Pa.
(3) Rural	State College Pa.
(4) Marine (Atlantic coast)	Sandy Hook N.J.
(5) Rural marine	Key West Fla.

Consideration of the time to first perforation of coated and uncoated specimens reveals that, without

Fig. 1.—Storage building for Massey-Harris-Ferguson Ltd. supplied and erected at Toronto, Ontario.

(Courtesy of Octavius Atkinson and Sons Ltd.)



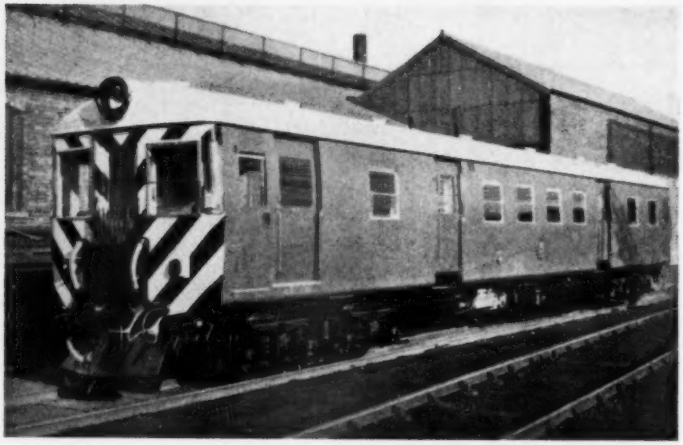


Fig. 2.—The roof of the diesel coach is fabricated from continuously galvanized strip.

(Courtesy of Craven Carriage and Wagon Co. Ltd)

any maintenance, there is a very large increase in the service life of the former compared with the latter. With maintenance painting carried out at some intermediate stage before the first appearance of rust, and regularly thereafter, an indefinite life would be obtained but the maintenance actually required would be substantially less and also simpler than with uncoated sheet.



Painting of Galvanized Steel

With regard to the actual painting operation some sheet is supplied with either a chromate or phosphate finish and these serve as an excellent basis for paint. Alternatively a galvanized surface, roughened slightly by weathering, provides a good key, and prior to painting, it is only necessary to brush the surface lightly to remove dirt and loose corrosion products.

Today paints are also available for direct application to freshly galvanized steel. While pretreatment by phosphating or the use of etch or wash primers is still common practice, paints pigmented with calcium plumbate, or the zinc dust/zinc oxide paints, may be applied directly to the galvanized surface. These paints exhibit excellent adhesion on freshly galvanized surfaces. The choice of the outer or top coats should of course be governed by the nature of the environment in order to achieve the best results.

Conclusion

With ever increasing attention being paid to corrosion prevention, galvanizing, although one of the oldest methods of protecting steel, is finding increasing application. New techniques have resulted in great improvements in the process but the life of a galvanized coating is nevertheless governed by its thickness and by the aggressiveness of the atmosphere to which it is exposed. While a life of 20 to 30 years is common for coatings of 2 oz. per sq. ft. (of surface) exposed in unpolluted atmospheres, proper maintenance will result in an indefinite life for the coating even in severely contaminated atmospheres.

Fig. 3.—Galvanized strip used for works ventilating ducting.
(Courtesy Andrew Machine Construction Co. Ltd.)

PROCESSING and PAINTING of SHEET-METAL COMPONENTS

By W. STEIN* and E. PODMORE*

(*A Paper presented at the Annual Conference of The Institute of Sheet Metal Engineering, London, November 5 and 6, 1958*).

Introduction

THE description " sheet metal " covers a very wide field and it is the intention to discuss in this paper the preparation and organic finishing of the more commonly used materials : mild steel, bare and pretreated ; aluminium and its alloys ; and brass. Reference will be made to the treatment of sheet as such and to the painting or lacquering of articles produced from sheet or strip by forming, like drawing or pressing, and by fabrication.

Degreasing and Cleaning

Although it is common knowledge that adequate cleaning is the basis for any successful organic finishing, this knowledge is not always applied. All too often are metal parts, which, in their hundreds, have been dipped in the same bucket of trichlorethylene, described as " degreased " and the inevitable failures are blamed on anything except on the obvious reason. Because it is felt that sufficient consideration is not always given to degreasing and cleaning, it is proposed to deal with the points arising in planning an industrial cleaning operation. The first questions are :

(1) What metal or combination of metals is to be treated ?

(2) What materials form the contamination ?

(3) What degree of cleanliness is required ?

A second set of questions refers to the mechanism of cleaning which can function, according to circumstances, by one or a combination of two or more of the following ways :

Mechanism of Cleaning

(1) Dissolution by organic solvent.

(2) Mechanical removal, aided by the low surface tension of the cleaning solution. This tends to lift particles and liquid films off the metal surface. This type of cleaning can be made more effective by spraying under pressure.

(3) Saponification by alkaline cleaners of contaminants which consist wholly or mainly of saponifiable oils, fats, waxes or greases.

(4) Emulsification of the contaminants and reducing the effective particle size by breaking-up large flocculates and aggregates into small particles or droplets which can be dealt with by the cleaner.

(5) Practically all these systems can be combined with the action of sonic and ultrasonic waves which loosen dirt particles by vibration. This aid to cleaning is often found valuable for removing swarf from blind drill holes and complicated passages.

(6) Another approach is to utilize for cleaning processes the gassing that occurs in electrolysis, but this method is mainly used prior to electroplating.

Whatever the cleaner and mechanism of cleaning, a most important point is that the removed dirt will, in some form or other, remain in the cleaner for some time in increasing concentration. Any cleaning operation is faulty which does not allow this mixture to be rinsed off the cleaned goods without leaving residues or deposits.

Another consideration is that cleaning, like any other step of a process sequence, should never be regarded as a process on its own. Relatively small changes in previous operations can make cleaning easier, cheaper and more effective, just as the type of cleaning can materially aid or hinder subsequent production steps. To mention just one example, it was practically impossible to clean some brass covers after annealing because of burned-in residues of drawing lubricants which formed a crust-like scale. The trouble was cured, not by altering the cleaning procedure, but by introducing a water-soluble drawing lubricant which can be removed before annealing by a simple water swill. Similarly, polishing compounds should be capable of being easily removed by saponification or emulsification.

Vapour Degreasing

Vapour degreasing, in this country almost invariably by trichlorethylene, has many advantages, conferred by the good solvent power, low specific heat, low heat of vapourisation and good penetration owing to low surface tension of the solvent. On the other hand, trichlorethylene is a narcotic, is not cheap and acts only by dissolution so that, if solids are present, these are not, as a rule, completely removed. This can, to some extent, be overcome by liquor or combined liquor-vapour degreasing.

It is not always realized in the production shops that vapour degreasing takes place only while the articles are colder than the vapour, when the

*Joseph Lucas Limited, Birmingham, 19.

condensing liquid dissolves and washes down the contaminant. From this it follows that :

(1) It is more difficult to degrease thin articles in one stage because, in view of their small mass and relatively large surface, they may be heated to the boiling point of the degreasing liquid before they are clean and,

(2) It is useless to expect articles to become cleaner if they are put in a vapour degreaser and left there for some time.

Alkaline Cleaner

The ideal condition for the use of an alkaline cleaner exists when the material to be removed is saponifiable—that is capable of being converted into an alkali soap. Such soaps are water-soluble and easily swilled-off. A large number of different alkaline cleaners is in use ; most of them are sold as specialities by supply houses and practically the whole metal-using industry buys proprietary cleaners. Whatever the claims made, all materials of this type consist of some of the following ingredients:

Caustic Soda (Potash), Sodium Carbonate, Sodium Silicates, Sodium Phosphates, Borax, Soap, Detergents.

Alkaline cleaners are most versatile and are used for a diversity of applications both by ordinary dipping and in mechanized plants.

Emulsion Cleaners

Emulsion cleaners consist of an aqueous detergent solution which holds organic solvents like trichlorethylene or kerosene in the emulsified state. These cleaners are relatively cheap to operate and are particularly useful for jobs where the highest degree of cleanliness is not required or where a second cleaning stage follows. An advantage of this type of cleaner is that it does not etch non-ferrous metals, provided the aqueous part is not alkaline.

Di-phase Cleaners

A fairly recent development in the metal cleaning field is the introduction of di-phase cleaners. These are not dissimilar from the emulsion cleaners in the respect of composition, because they also consist of aqueous and organic solvent constituents.

In its usual form a di-phase cleaners has as its aqueous component a rather weak emulsion in water of the organic solvent and a petroleum hydrocarbon as the solvent phase.

On withdrawal after dipping, a film of the hydrocarbon, usually paraffin, is left on the articles. This can be removed by mild alkaline cleaning, but is often left on the articles as temporary inter-stage protection.

In another form, work can be sprayed by means of an arrangement which ensures that the pump inlet is so placed that both phases are simultaneously drawn from the tank.

Naturally, if the solvent used is heavier than water, say for instance, trichlorethylene, then the two phases will be reversed.

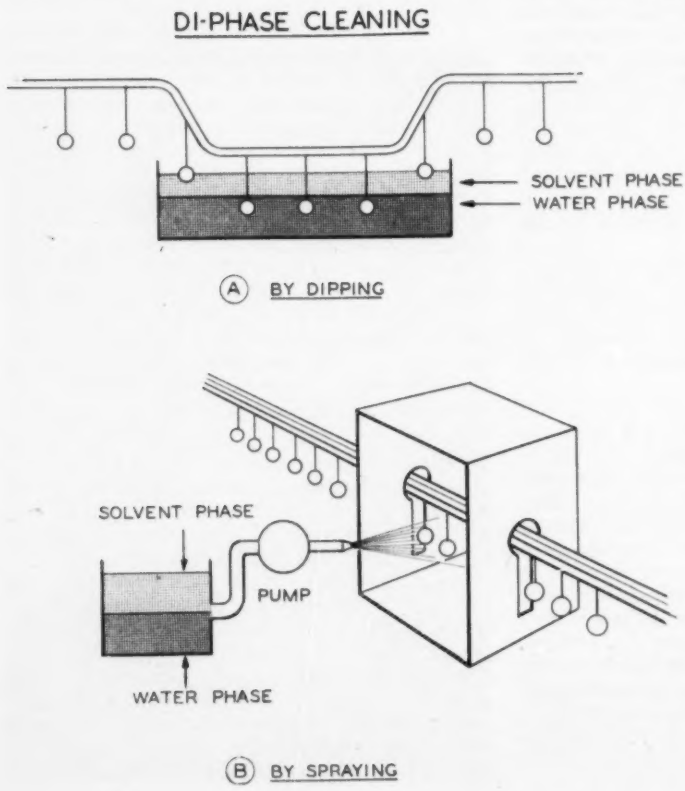


Fig. 1.—Diagram of two methods of di-phase cleaning

Pretreatment

Phosphating

The requirements for the service performance of painted articles, sometimes under severe conditions, have become more demanding, but it can be claimed that the protection afforded by organic finishes has kept step with the higher standard required. Probably the most important single contribution to this progress is the development of satisfactory phosphating materials and techniques. Phosphating of steel—and sometimes of zinc—produces a film which gives excellent paint adhesion and arrests the creep of rust under the paint film from areas of accidental damage.

The modern trend in phosphating as a pretreatment for subsequent organic coatings is towards lighter phosphate films. It has been found that on articles which have to withstand tropical climate and often continuous splashing with water and even mud, a fully satisfactory finish can be obtained—provided the paint and the processing are right—with a layer of 160 to 200 mg. per square foot of zinc phosphate. An increase in phosphate thickness does not seem to have a beneficial effect and causes, beyond a certain limit, higher paint consumption and loss in gloss.

These remarks apply, however, to a minimum thickness of phosphate film and not to an average value which, in extreme cases, could be calculated on a badly processed article as the mean between areas having a heavy phosphate film and others which are bare.

New Development in Phosphating

A new venture in phosphating is represented by the claim that adequate phosphate films can be produced at only slightly elevated temperatures.

This claim is, at the time of writing, being made by several manufacturers and plants are already operating in this country using the new solutions. It needs no emphasizing that phosphating at, or slightly above, room temperature would represent not only a considerable saving on fuel and on exhaust plant installation, maintenance and operation, but would also eliminate, or at least minimize, the biggest trouble in phosphating plants, the formation of hard crusts of sludge on heating coils and spray jets.

The new material will need careful testing and evaluation, but the authors feel sure that almost everyone who has to apply phosphate coatings will be keenly interested in this development.

Pretreatment of Non-ferrous Metals

Non-ferrous metals require different treatment and the various metals are usually treated as follows:

Aluminium

This is fairly corrosion resistant because the metal quickly develops a protective oxide film. Painting on aluminium, however, is unsatisfactory, unless some pretreatment is carried out. Two types of processing materials are being offered as proprietary chemicals. One is an alkaline bath which is operated hot. It produces a substantial film on the aluminium providing excellent paint adhesion. The disadvantage of this process is, apart from the cost of heating, the fact that the solution is strongly alkaline and needs careful removal from the articles because even traces of alkali under a paint film are sure to cause trouble.

The alternative is an acid solution, similar to the American " Alodyn " material, which is based on chromate and fluoride. This solution is obtainable under proprietary names in this country and is used at normal or only slightly elevated temperature. Work carried out in the laboratories of the authors' firm has established that, apart from materially aiding paint adhesion, the deposited film gives considerable corrosion protection even on unpainted components.

It must be realized, however, that the acidic treatment is only successful after good cleaning, while the alkaline process is far less critical in this respect.

Brass

The adhesion on brass of paint and lacquers of all kinds, with the exception of some epoxy-hydrine based materials, is bad. Although this has been pointed out frequently, attempts are still made to save a process by omitting preparation of the metal. This is a poor practice and almost invariably leads to peeling or flaking of the paint film. It has to be faced that an unprepared brass surface ought not to be painted.

The simplest treatment is by short immersion in an alkaline tin solution. Alternatively, thin electro-deposits of tin or tin-zinc are perfectly satisfactory.

Pretreatment—Summary

The treatment of articles prior to painting has been dealt with at some length, but it is felt that the importance of good cleaning and preparation cannot be overstated. The authors are sure that added attention to the pre-painting phases of finishing will, in many cases, eliminate trouble and improve the final product.

Organic Finishing

(1) *Materials*

The paints applied to sheet-metal components are divided into the following main groups :

(a) Primer.
(b) Surfacer (filler, stopper, sealer, undercoat).
(c) Finishing enamel or lacquer (colour coat).

According to the service conditions to which the articles will be subjected, one or more layers to paint from these main groups are applied.

While on a motor car, for instance, the finishing schedule includes materials from each of these groups, expendable articles, like cheap toys, some tin boxes and food cans, are only finished with a single coat of paint.

Function of Paint Coats

Each of these groups of materials has its specific function.

The *primer* has to ensure good adhesion between metal and the whole of the paint system and has to provide corrosion protection, mainly by the action of special chemically acting pigments, of which zinc tetrachromate is the best known example.

The *surfacer* serves for the filling of irregularities, tool marks and scratches on the metal. This relatively thick film is, as a rule, manually abraded in order to obtain a high degree of smoothness.

The *finishing coat* determines the appearance of the articles regarding colour, gloss and final appeal.

Any attempt to discuss the chemistry of organic finishes would fall outside the scope of this paper which is to deal more particularly with methods of application. For this reason, no reference is made to classification and composition of paints and finishing materials.

Methods of Paint Application

It may be a surprise to realize that from prehistoric times until about 40 years ago the only known methods of applying paint were dipping and brushing. The advent of the first synthetic resins—nitrocellulose—stimulated the development of spray guns and the rapid appearance of improved finishing materials resulted in new tools and processes for quicker and more efficient ways of applying paint. This development occurred within an industry which adapted itself more and more to mass production with automatic plant and flow-line systems so that, nowadays, painting in industry has become the final stage in a sequence of engineering operations.

Paint is applied in production shops by a number of processes of which the following are most frequently used :

(1) Dipping and flow coating.
(2) Spraying.
(3) Roller and curtain coating.
(4) Silk screening and printing.

Dipping and Flow Coating

The simplest methods of painting on an industrial scale are dipping and flow coating, although the latter does not, as a rule, provide a high degree of surface perfection. The success of dipping depends not only on the obvious condition that the shape of the components must be suitable for the process. It is also necessary that the withdrawal time be adapted to the size of the article and that the properties of the paint, like viscosity and solvent evaporation, be determined for each plant and be carefully controlled and maintained. Generally speaking, slow extraction will produce thinner and more regular paint films, while rapid withdrawal will give thicker coats with an increased chance of blemishes.

There are, however, exceptions to this rule and this will be illustrated from the authors' own experience.

It was necessary to provide on domed steel pressings a paint finish having a degree of surface smoothness far in excess of normal industrial requirements. In addition, the painted articles were required to be completely free from blemishes often associated with inadequate dipping technique like " sags," " curtains " or " runs."

It was soon clear from preliminary work that the necessary high quality of smoothness could not be provided by dipping at the withdrawal rate normally obtained by the slope possible with monorail overhead conveyors. The obvious answer, a withdrawal time in the order of several minutes, would have been most inconvenient and would have required excessively large plant. Experiments have indicated, and experience on production scale has proved, that excellent results can also be achieved by going to the other extreme, that is to install equipment for very rapid extraction.

The method developed is remarkably simple : Jigs carrying six components each are connected by two linked rods to the conveyor. The upper member carries a fixed cross bar which is set as right-angles to the direction of travel. Shaped guide rails engage this arm and control its upward movement while the conveyor moves forward. This lifts the jig much more rapidly from the dip tank than would be the movement caused by the conveyor slope alone. The actual time of withdrawal for the whole loaded jig is less than 10 seconds, which is about one third of the fastest time possible on the existing plant without this arrangement.

Fig. 2 shows the principle of the articulated jigs and the lifting rails. This method is applicable on horizontal conveyors where the whole of the immersion and extraction can be controlled by the shape of the guide rails largely independent of conveyor speed.

Attention should be drawn to the importance of control of solvent vapour concentration in the region of " flash-off." High vapour concentration retards drying and aids flow, sometimes to an embarrassing degree, and troubles like streaks and solvent wash can occur.

Dipping is sometimes combined with rotating the articles during immersion, drying and stoving. This technique aids even flow and produces substantial paint films in a single application. This method is

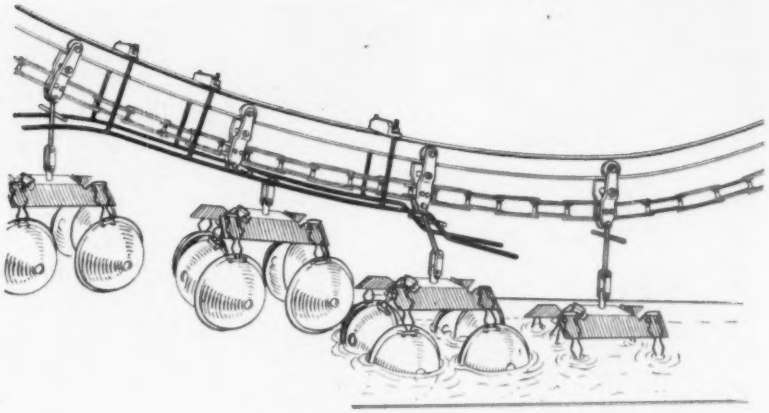


Fig. 2.—Arrangement for rapid withdrawal of components from paint vat

employed in the finishing of such articles as motor-car road wheels.

The installations where whole motor-car bodies are dip-painted while suspended on rotating spits in the well-known " Rotodip " plants have been fully described in the technical press.

Flow coating, which consists of directing jets of paint on to the articles and collecting and recirculating the excess, is useful for the finishing of certain components. The main advantage of this process is that it lends itself to the finishing of long articles which can be suspended vertically and that only a small tank with a relatively small quantity of circulating paint is needed. A horizontal conveyor allows simple methods of jigging with better utilization of plant. Articles can be treated whose shape would make them prone to air locks, if conventional dipping methods were employed.

Paint Application by Spraying

The by now conventional method of atomizing paint by means of spray gun using compressed air is supplemented by various modifications, such as hot spraying, steam spraying and electrostatic application by the Ransburg No. 1 process.

Generally speaking, spraying, particularly on non-automatic plant, is carried out where the articles cannot be processed by a more convenient and cheaper method. Most spray applications are extravagant in paint consumption and losses due to overspray in the order of 60 per cent and more, according to the shape of the articles, must be expected. Another point to consider arises from the need to spray at relatively low viscosity and this naturally demands a large amount of solvent. This is necessary for good atomization and flow, but the solvent is lost afterwards by evaporation.

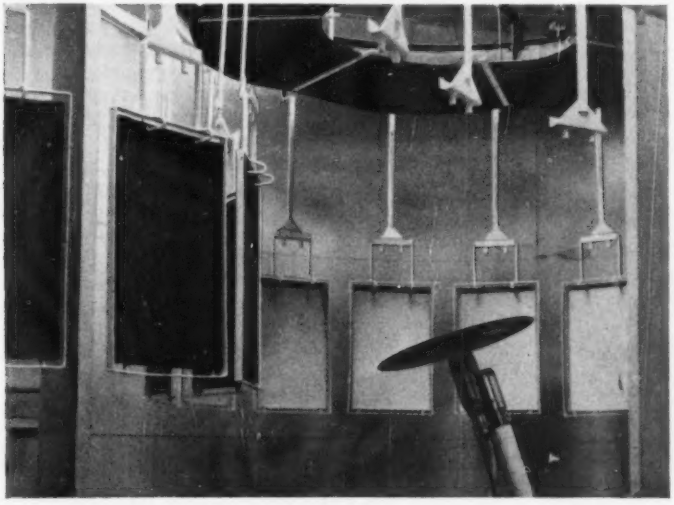


Fig. 3.—Electrostatic spraying of metal panels by disc method

(Courtesy of Henry W. Peabody (Industrial) Ltd. and Hoover Ltd.)

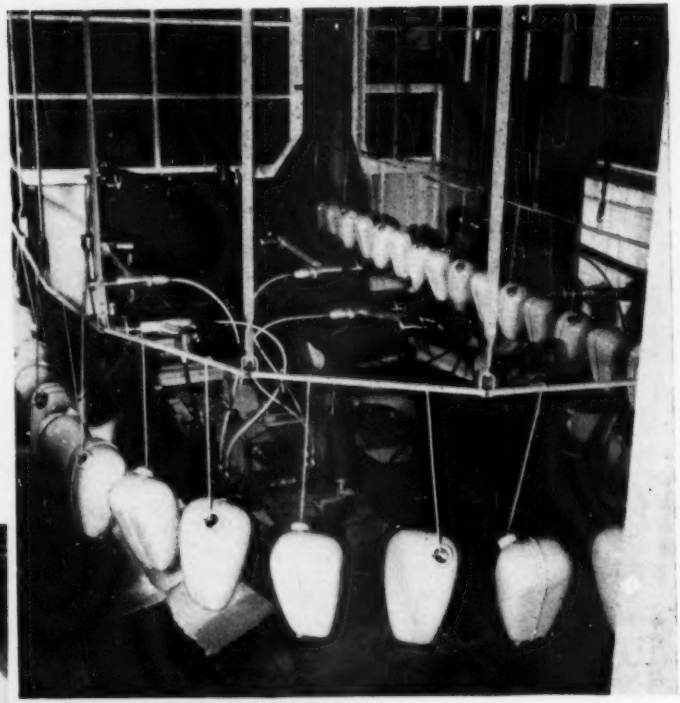
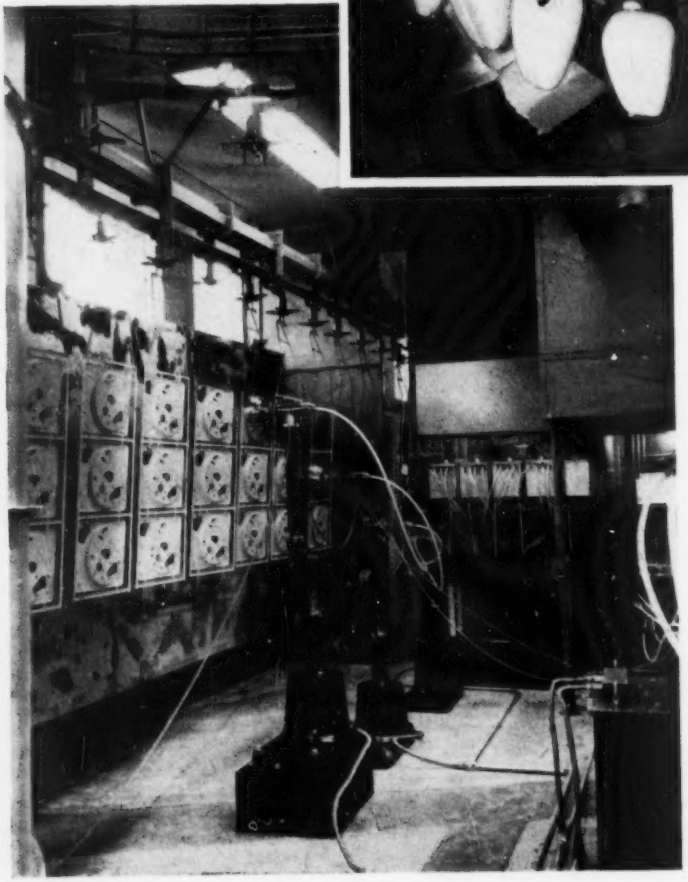


Fig. 4 (bottom)—Spraying, by triple head cone, of gramophone parts

(Courtesy of Henry W. Peabody (Industrial) Ltd. and Garrard Engineering Co. Ltd.)

Fig. 5.—Spraying of motorcycle tanks, cone application

(Courtesy of Henry W. Peabody (Industrial) Ltd. and N.S.U. Works.



Hot spraying was introduced some years ago, but this process has not gained the support which was originally expected. Hot spraying has definite advantages for certain operations, particularly where thick films are required in a reduced number of applications. This is achieved by lowering paint viscosity by increasing temperature instead of thinning with solvent. Although results obtained by this process are very satisfactory : the handling of the gun requires more physical effort from the operator than an ordinary spray gun and much more maintenance is needed.

Steam spraying is a process in which compressed air is replaced by superheated steam. This method is in use in several American factories, but has not gained popularity in this country.

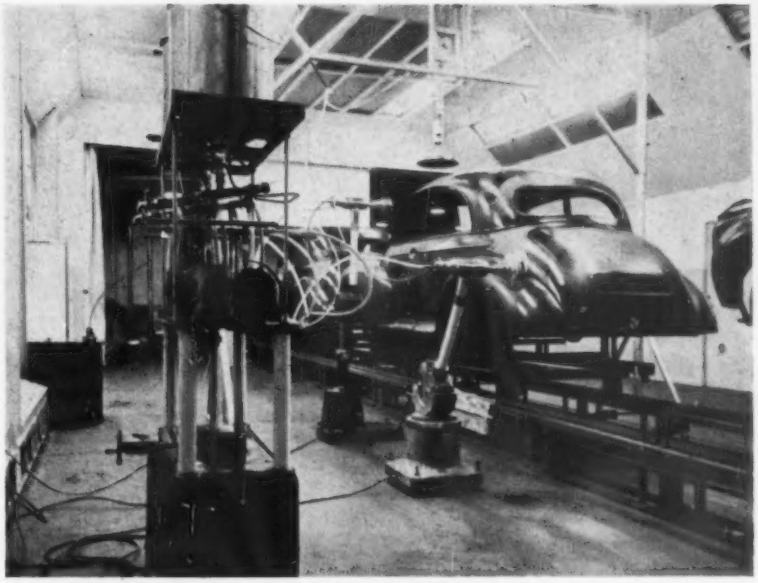


Fig. 6.—Spraying of car bodies. The top cone is arranged to follow the contour of the passing body

(Courtesy of Henry W. Peabody (Industrial) Ltd. and British Motor Corporation)

Electrostatic spraying by atomization with compressed air (Ransburg No. 1 and similar processes) consists of spraying the paint into the space within a wire cage through which the articles travel on a conveyor. The cage is charged with an electrostatic potential in the order of 120 kilovolts and the charged globules of paint are attracted to the components which are, together with the conveyor, at earth potential. A good "wrap round" effect is achieved and considerable paint economy is obtained because overspray in a well controlled plant is negligible. This system is used to best advantage on continuous production runs of articles having similar size and shape.

This and other electrostatic processes are suited for the treatment of flat and convex surfaces but the painting of concave portions and recesses often requires additional measures. For instance, car headlamp bodies are painted by spraying the insides automatically with a conventional spray gun after which the components travel through the electrostatic spray booth for painting of the exterior surfaces and flanges.

Automatic spraying can be carried out in many forms, and is of use wherever the number of components to be processed merits specialized installations. The movement of the gun can be controlled by mechanical or "electronic" servo systems and a considerable amount of ingenuity has gone into sometimes elaborate switching arrangements which ensure that overspray is largely avoided in order to achieve maximum paint economy.

"Airless" Processes

Methods utilizing spraying without the use of compressed air or steam have many attractions, mainly because conditioned compressed air is expensive and because the often occurring overspray necessitates elaborate spraying booths. These require much maintenance and often provide unpleasant working conditions.

Spray guns which atomize hot paint which is fed to the gun at considerable pressure, have recently been introduced. Atomization occurs on release of pressure when the paint leaves the gun, the rapidly expanding solvents causing dispersion into very fine globules. This process is relatively new and, as equipment improves, is gaining support. The main application is for the treatment of large units having mainly flat surfaces. The greatest attractions of this method are the high speed of spraying due to the large areas covered in a single pass of the gun and the small amount of overspray. Consequently, ventilation requirements are reduced. A difficulty experienced initially was excessive nozzle wear, but this trouble has been largely overcome by improved design and the use of more suitable materials.

Airless Electrostatic Processes

The modern processes of this kind, notably by the Ransburg equipment, are by now well known and in extensive use. Paint is fed through a hollow shaft to rotating discs or cones and charged to a potential of about 80 kilovolts. As the articles, which are at earth potential, pass through the

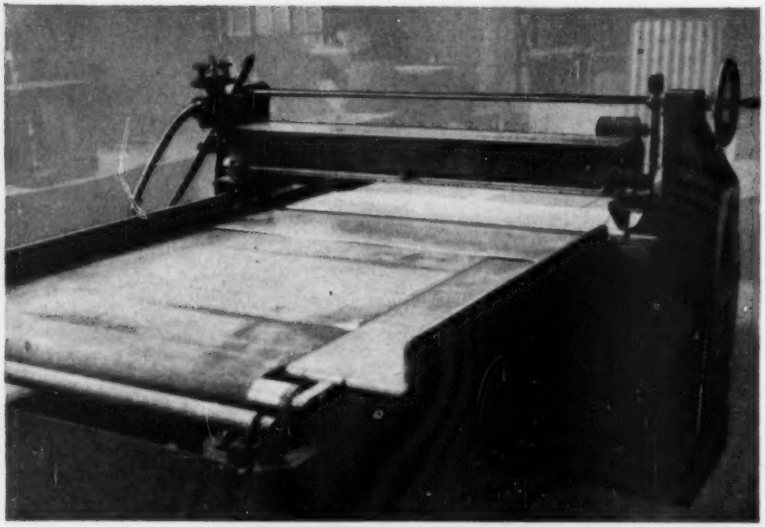


Fig. 7 (left).—Curtain-coating machine

(Courtesy of Cellon Ltd.)

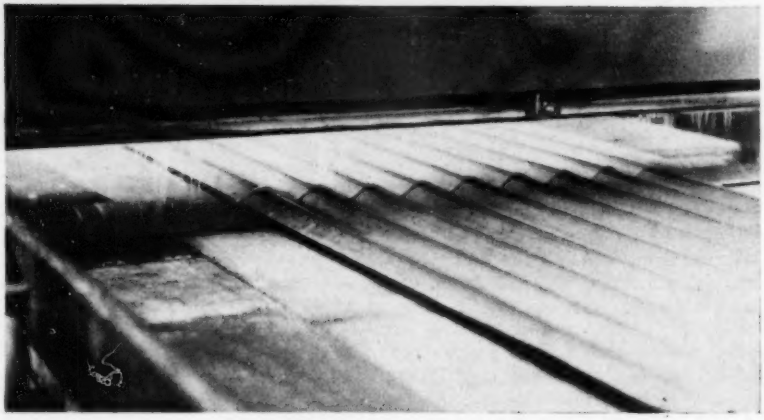


Fig. 8 (below).—Curtain-coating of corrugated sheet

(Courtesy of Cellon Ltd.)

electrostatic field paint in the form of fine droplets is drawn from the periphery of the rotating disc or cone and deposited on the components to be painted. For larger units to be processed, discs can be made to move, reciprocating in one plane, and can be arranged so that two or more painting heads operate simultaneously. This process has all the advantages of the "Number One" method and, in addition, can be utilized for larger articles of more complicated shapes and does not require compressed air for atomization. As the paint flow to the applicators can be accurately controlled, the thickness of the applied film can be held constant.

Like other electrostatic painting installations, this system will give the best paint utilization and will apply more consistent coatings if attention is given to uniform conveyor loading.

Current patent literature lists many other examples of electrostatic painting apparatus and it appears that much inventive thought is directed towards avoiding restrictions by existing patents. Though some of these inventions look quite attractive theoretically, the authors are not in a position to comment on them on the basis of personal experience.

Figs 3 to 6 show a few typical applications of this process.

Roller and Curtain Coating

Roller coating is used industrially on a very large scale. The products treated by this process are mainly tinned sheet for the canning industry and for boxes and containers of all descriptions. The principle of roller coating is simply to apply paint or lacquer to a rotating cylinder which transfers the liquid material to flat sheet travelling beneath it. The process can be used at very high production rates and, though close control of material and processing conditions is necessary, works on the whole with little trouble. It is obvious that this process is really a close cousin to roller printing which is often used for applying a second, often decorative, coating to already roller-coated strip or sheet.

A fairly new development, also directed towards obtaining high-speed production of painted sheet, has been introduced by Swiss and German firms. This process, which has been given the descriptive name of curtain coating, operates as follows : Paint or lacquer is pumped into a tank to a controlled level. The paint or lacquer is then allowed to flow freely from an elongated thin opening (which is controlled in width), so forming a continuous coherent "curtain" of paint. The paint falls into an opening between two endless conveyor bands and reaches a reservoir from where it is recirculated. Articles to be painted are placed on to the conveyor and travel at considerable speed through the curtain of paint, thus receiving a uniform coating. A speed in the region of 150 to 200 ft. per minute is considered average.

The advantages of this process are that relatively substantial films can be applied in a single passage and, particularly, that articles to be processed have not to be completely flat. Figs. 7 and 8 show a curtain coating plant of German manufacture processing corrugated sheet metal.

Conclusion

It is realized that any attempt to compress a subject as large as " Processing and Painting of Sheet-Metal Components " into a paper of reasonable length must lead to superficial treatment and to omissions. The authors will, however, try to answer any queries that may arise during the discussion.

Acknowledgement

The authors thank the directors of Joseph Lucas Ltd., Birmingham, for permission to prepare and present this paper.

* * *

Dr. W. STEIN, in presenting the paper, said that a large proportion of it was concerned with cleaning, because the authors felt very strongly that this important item was often the "Cinderella" of the finishing process as carried out in a works. There were some points which he would like to emphasize which might not be brought out in the printed paper as strongly as was desirable. One was that in areas where there was hard water a real problem existed in regard to swilling, particularly with phosphating processes. It might be advisable to use demineralized water, but that introduced an additional complication and caused additional expense. In the long term, however, it was probably good policy to do so in certain cases.

A reference was made in the paper to the use of trichlorethylene. It was necessary to make sure that the liquor was kept in a reasonable degree of cleanliness, which could be done in the most convenient way by re-distillation. Too often the liquor contained a fairly concentrated solution of oil and when the trichlorethylene dried off, the oil would be left on the article, so that the position after cleaning might be worse than before. Mechanical agitation of the articles or of the cleaning solution was always helpful, whether a high pressure spray was used or, when dip cleaning, even gentle agitation.

He would like to say an additional word about the very great necessity for proper rinsing after alkaline cleaning. This was one of those things which was so obvious that it seemed almost childish to mention it, but there was more trouble with alkali left on an article than from many of the other faults taken together. It was worth remembering that in the factory the work was not always carried out so thoroughly as the process sheet demanded and it was a good plan to keep an eye on that. If alkali were left on the article it would act as a "built-in stripper."

One of the weaknesses often connected with phosphating was the practice of sanding down the article. Very often that sanding went right down to the base metal and the phosphate film was removed. It was obviously unfair to blame the phosphate film for inadequate performance when it was not there any longer, but that was often done. There was not much which could be done about this, apart from improving the design by increasing radii and by determining the standard required. It was the question of policy and customer demand which was directing the amount of sanding necessary. From the point of view of durability a better article would be produced if less mechanical work was done on it after phosphating. He had in mind, in particular, motor car bodies and was convinced that most of the corrosion trouble was due more to mechanical work after phosphating and priming than to any basic weakness of the process or the material. Since the authors wrote about cold phosphating, they had seen one or two more baths in operation and had experimented themselves. They were convinced something good was coming along, or had even arrived already. There were two cold phosphating solutions on the market in this country, to his knowledge, from two highly respected companies. One was a solution based on hydrogen peroxide as the accelerator and the other was claimed to be a modified but otherwise conventional nitrate-accelerated solution. They both worked. The authors had not themselves had experience of them on a large-scale basis of operation, though they would soon obtain that experience, but it appeared that one of the main differences, if not the main difference, between the two, which might well have some meaning, was the amount of control needed in practice. It was obvious that phosphating was so easy that it was becoming almost industrial practice to rely on the

solution to remain in good order without too much laboratory control being necessary.

Very little has been said about paint finishing other metals than steel and those referred to, because it was very unusual on an industrial scale to paint stainless steel, lead, copper, and so on. Organic finishing could be applied for the sake of its decorative value or for the protective purposes. Most of the finishing done by the industry was probably for a dual purpose, and both were wanted. When the authors spoke of flow coating there was one important point which had not been mentioned, namely, that it was possible very conveniently to flow coat articles which could not be dipped because they were hollow and would float. Articles such as motor-cycle tanks were very easy to flow coat, but were quite a nuisance when dipping was used.

In the September issue of the American journal *Industrial Finishing*, mention was made of a new airless spray used at room temperature. Apparently pressures of up to 2,000 lb. per sq. in. were used in the hoses. It would need a very good hose to deal safely with that pressure, although that should not be a major practical problem. Such a process would be expected, on the face of it, to be very attractive, but there were objections which would have to be overcome before accepting too readily what was being said about the process. One of those objections was that there would probably be rapid nozzle wear at the velocities resulting from a pressure of 2,000 lb. per sq. in. He would also expect a very considerable rebound of paint globules if shot at an article at such a very high speed.

Reference was made to curtain coating. Since then a further development had been made, and instead of relying on gravity for the paint to pour through the slot and go on to the article, the process was aided by actually pumping the paint and letting it escape from the slot under pressure. That was a logical development, and it was surprising that it had not been used before. In any case, improved control of curtain properties and curtain shape was claimed for this modification.

Dr. Stein then showed slides of the illustrations contained in the paper. Referring to Fig. 2, the arrangement for rapid withdrawal of articles after dipping, he said that for many years it had been an accepted rule to withdraw slowly in order to get a uniform smooth coat. The authors had gone to the other extreme on a very considerable scale, and found that it worked. The withdrawal speed was closely connected with the geometry of the article which was being processed, and to some extent a procedure of trial and error was necessary. In their own case at any rate, rapid withdrawal had proved to be the answer.

Dealing with Fig. 3, electrostatic spraying, he said that in one of the technical journals published in this country the statement had recently been made that the paint was thrown from the disc or belt by centrifugal force. That was not the case. It was hardly necessary to mention that the journal which gave the incorrect information was not *Sheet Metal Industries*. The centrifugal force was very small because the discs or belts moved very slowly, and if centrifugal force was used it would be impossible to persuade it to act only towards the article being treated and not all round; the paint would fly off tangentially and a great mess would be made in the shop. Fig. 7 showed curtain coating, such an obvious way of painting that it seemed almost a miracle that nobody had thought of using it until recently. Fig. 8 showed that it was possible to paint by the process in question articles which were not flat. In the picture corrugated sheet was shown, which would completely defy roller coating such as was normally used for the painting of sheet.

DISCUSSION

The CHAIRMAN (Mr. A. A. B. Harvey), while agreeing wholeheartedly with the authors that rinsing in the paint shop was probably one of the greatest single causes of trouble, said that water was, despite the British climate, a rare commodity and had to be paid for. It was almost unobtainable in industrial quantities and was sometimes of appalling quality. Had the authors any experience of control rinsing by *p*H or conductivity methods?

On cold phosphating, he said there was a tendency to think of phosphate processes in terms of the amount of sludge produced, which had to be disposed of at weekends and other times when extra rates of pay were necessary. Did the cold phosphating process described by the authors show any improvement in that direction?

There was a big tendency throughout the organic finishing industry for standards of inspection to be such as unrealistically to demand the touching-up of blemishes which would be negligible in their effect in service and not observed by anyone who was not looking closely for defects. Once a coat was broken down to fill up some blemish, the chances of repair which would have good durability were very small.

Dr. W. STEIN replied that there were some automatic conductivity meters for controlling the *p*H or conductivity of water, but he did not regard that as a satisfactory way of dealing with the trouble. One probably knew whether it existed or not. One way which was not new, but which was surprisingly little used, they had found to help a great deal in the conservation of water, and that was using tanks in cascade. Fresh water was put into the last tank and then went to the last but one, and so on, so that the article gradually went into cleaner water as it progressed from tank to tank, whereas the consumption of water was equal to that for one tank only. There were two problems involved. One

was the removal of processing solution which would leave chemicals like alkali on the article. That could be dealt with by sufficient rinsing with whatever water was used. The other arose from the hardness of the water, which was capable of causing trouble later on under a paint film because of osmotic blistering and so on. The two must not be confused. Where there was a really hard water, which by itself caused trouble, the only answer was to demineralize it. On the other hand, so far as swilling was concerned, it was merely necessary to do enough of it.

The point about sludge in relation to cold phosphating was a real one. The removal of sludge was a considerable nuisance, it cost man hours and was an unpleasant job. The sludge was only phosphating chemical which had been paid for, but in a less pleasant form. While he could not give exact figures to show the extent to which sludging was reduced by cold solution, he did not think there was any doubt that the reduction would be very considerable. There was a saving and the nuisance would be much smaller.

Mr. E. PODMORE, on the question of quality, said it was a question of who prescribed the quality of the job, the factory or the customer. They were very well aware of the problem involved in touching up, and too often the finished article was affected right down to the bare metal, so that there was an air-drying material on top of a stoving paint, and that would lead to premature breakdown. That did not alter the fact, however, that the quality had to be laid down by somebody, and, if this was what the customer demanded there was no way out of it. If the quality was laid down in the factory for price consideration it was necessary to look at the problem in a different way. When considering the quality of imported material, particularly in motor cars from the other side of the Atlantic, they had what was called a kerb-side finish, and it was disappointing to those in the trade to know that they had to produce an article which in appearance of the finish was so much better than what was supposed to be the acme of perfection.

There was no reference in the paper to screening. That had been omitted purposely, because it was not generally accepted as a protective finish ; but if any member cared to raise the question of screening and printing, he would try to deal with it.

Dr. STEIN said he was glad that Mr. Podmore had made that point. There was too great a tendency to confuse quality with appearance. He did not want to refer too much to motor cars, because many of his audience were more expert on that subject than he was, but it was a common fallacy to think that a good appearance necessarily meant better quality, because it was often the other way round. It was probably very much better to accept small blemishes and leave well alone rather than try to repair them and so obtain a job which looked good but would soon be found not to be so.

Replying to Mr. GLOVER, who asked a question on epoxy-primers, Dr. Stein said there was at least one firm in this country, and several in the United States, which used epoxy-type primers. They had certain advantages, one of them being that epoxy-type paints had adhesion which was very much superior to what could be expected from the more conventional materials. He could not say off-hand whether the creeping of rust under the primer would be sufficiently retarded or prevented if proper phosphating had not been applied under the epoxy-type primer. The phosphate in a conventional paint scheme acted not merely to improve adhesion ; a major function was to prevent rust creep. It was probably that a reasonable phosphating was necessary for that reason alone, whatever the nature of the subsequent organic finish, because it was necessary to cater to some extent for the possibility of accidental damage. So far as large-scale application was concerned it, always came down in the end to a question of price. A reasonable product was desired, and if it was possible to put on a primer such as an epoxy-type primer, which would help on other operations and be as good or better, it would go in, provided the cost was not too great, but if it costed considerably more he did not think it would be much used.

Etch Primers

MR. PORTER (Aluminium Development Association) remarked that the authors had obviously had difficulty in compressing so much information into a short paper, but he wondered whether in the section dealing with the pretreatment of aluminium they had intended to omit reference to pretreatment primers, etch primers. The authors would probably agree that these should be regarded more as a pretreatment than as a paint coating, and, if they were used, they avoided the necessity for the other chemical treatments which were referred to. Second, straight phosphate treatments were used to some extent on aluminium as well as on other materials.

Mr. E. PODMORE replied that the use of etch primers was not a substitute for a coat of paint and there would still be need for another coat of paint on top, so that basically it should come under pretreatment, and as such it was a matter of economics, and whether it was a question of acidic treatment or alkaline treatment. With aluminium the result was much more in favour of chemical pretreatment than etch primers. There were, however, instances where it was more suitable to use etch primers than chemical pretreatment, depending on the shape of the article and the numbers being processed.

(*Continued in page* 112)

Pressing and Painting of Sheet Metal Components

(*Continued from page* 111)

With regard to the phosphating of aluminium there were materials which would do this job ; against etch primers there was the drawback that generally they fell under the cellulose regulations, because the flashpoint was low, which made them difficult to use. There were some etch primers used by the aircraft industry which were water-resistant. They were usually black or dark green or dark grey in colour, and they were very good, but they had no compatibility with cellulose.

Dr. W. STEIN added that the etch primer for practical purposes had to be hand sprayed and sprayed by a good sprayer, and good sprayers were hard to find, whereas the chemical treatment could be applied by dipping or by automatic spraying. That in itself was a major consideration when thinking in terms of mass production. The etch primers were usually two-pack solutions. The one-pack solutions were not, in the author's experience, of the same quality. They had found that it was almost impossible in the spray shop to train people to mix A with B without getting the wrong proportions. While mixing might be satisfactory in the laboratory, or if carried out by technical people, it had caused in their own shops a great deal of confusion. While etch primers or wash primers were in themselves a great help, and possibly the only help on some metals such as magnesium, they presented certain difficulties in application which did not arise with chemical treatment.

Mr. D. FLEMING (Stourbridge Rolling Mills Ltd.), said that a process similar to the curtain method of applying paint had been used by the glazed brick makers for many years. They had a tank and allowed the liquid glaze to flow over a weir on to the bricks, and they found that by having a serrated edge to the weir they obtained a more even coat and fewer blemishes and blowholes. They actually used a hacksaw blade for the serrated edge.

Dr. STEIN remarked that that was very interesting and quite new to him. He could not say off-hand why that effect was obtained.

Mr. FLEMING remarked that the people who used it did not know either, but the fact was that a more even flow was obtained, and they did not get the rejects which they had had before.

Mr. PODMORE said he could understand why a more even coat was obtained, if the weir was not of great length. A major problem was of surface tension from the edges of the curtain. In the normal way, when pouring there was far greater flow in the centre than at the edges. If that were broken up it would split up into a number of small curtains and there would not be so much alteration from the centre to the edge ; but why there were fewer blowholes he did not profess to know.

PRESSED STEEL COMPANY EXTEND IN DOMESTIC APPLIANCE FIELD

THE introduction of further new products by the Pressed Steel Co. Ltd., has been foreshadowed by Mr. M. A. H. Bellhouse the company's deputy chairman, at the recent ceremony of the laying of the cornerstone of the company's new factory at Swansea by the Parliamentary Secretary to the Board of Trade.

The new factory will at first be used for the production of refrigerators, a field in which the company are already well established, but as soon as possible other lines of household equipment will be manufactured, some of it under licence from the company's American associates. The Whirlpool Corporation, who are one of the largest producers of home laundry and household appliances in the U.S.A. This project represents an entirely new field of activity for the company although it is a natural extension of the licence agreement made some years ago with The Whirlpool Corpn. in connexion with certain types of refrigerator compressors now incorporated in some "Prestcold" designs. All Whirlpool equipment is of very advanced design ; washing machines, for example, incorporate such features as built-in germicidal ultra-violet lamps which sterilize the clothes as they are washed. In addition to washing machines the Whirlpool range includes automatic dryers, washer-dryers and ironers, electric, electronic and gas cookers, refrigerators, kitchen refuse disposers, kitchen cabinets, dish washers, and domestic air-conditioning plant etc.

At the cornerstone ceremony the Parliamentary Secretary to the Board of Trade, Mr. John Rodgers, M.P., was supported by Lord Brecon, Minister of State for Welsh Affairs, and among other speakers, who welcomed the Pressed Steel project was Sir Miles Thomas, Chairman of the Development Corporation for Wales, who said that any industrialist who is thinking of expanding or who wants to set up a factory in the British Isles could not do better than expand into Wales.

A tribute to the co-operation of the Board of Trade and of all the various authorities concerned in planning, building and equipping the new factory was made by Mr. Bellhouse ; Mr. J. R. Edwards, managing director, explained the way in which the company arranged its relations with the workpeople.

The new factory will be a completely self-contained manufacturing unit using all the latest production techniques and will also provide Pressed Steel with additional space for the production of motor-car bodies at Cowley and Theale. The total site area of the new factory is more than 50 acres and it is intended that the majority of the labour force to be employed will be recruited locally.

NEW THERMO-CHEMICAL TECHNIQUES - 1 *Bright Annealing*

by P. GALMICHE, Ing. Dr.

In this article, descriptions are given of various new techniques derived from the ONERA process of bright chromizing, which can be carried out by using the same equipment. Part I describes the bright annealing of steels and refractory alloys, while Part II, which will appear in a future issue, deals with different applications of the hot chromizing process and of reducing atmospheres halogenized " at equilibrium " in powder metallurgy. Mr. Galmiche is with the Office National d'Etudes et de Recherches Aeronautiques (ONERA), France.

THE ONERA process of chromium diffusion, in which chromium is diffused into the surface of the pieces being treated by means of chromium fluoride vapour[1] enables smooth and bright chromium surfaces to be obtained direct on ferrous metals even though the operational temperature may exceed 1,000°C. (for periods of treatment of the order of 1—6 h) and though the chromium content of the surfaces of the treated parts may be very high (about 50 per cent).

The quality of the surface obtained by chromium diffusion in a fluoride atmosphere is due to the following causes : (*a*) freedom from etching of surface during heating up, owing to the low volatility of fluorides of iron, nickel or cobalt, which form a thin protective coating, this being reduced at treatment temperature (halogens of iron, other than fluoride, are by comparison very volatile) ; (*b*) diffusion of chromium obtained by dissociation of chromium fluoride fumes without exchange reaction, that is to say without removal of metal from the parts treated ; and (*c*) formation in the treatment zone of a reducing atmosphere fluoridized " at equilibrium," which is inert as regards the metals under treatment but in which no oxide is stable.

The ONERA process of bright annealing of steel and refractory alloys consists of the use, for annealing, of reducing atmospheres halogenized " at equilibrium " similar to those which are produced in the ONERA process of bright chromizing. The plant used is also the same[2].

Bright annealing process

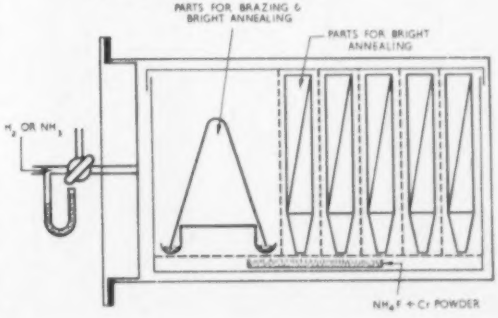
The methods of working are simple. The workpieces are put inside a nearly airtight box in the presence of ammonium fluoride and of chrome or ferro-chrome in powder or granulated form, this being kept from contact with the workpieces by a grid, although some of the ammonium fluoride, on the contrary, can be in contact with the parts. The treatment boxes are heated up in a reducing or neutral atmosphere, *e.g.* ammonia or hydrogen, at normal or under reduced pressure (Fig. 1).

On heating up, the ammonium fluoride reacts with the chromium powder and is dissociated, giving rise to the formation of a low-volatile reserve of chromium fluoride together with a mixture of gases, hydrogen, nitrogen, hydrofluoric acid, which drive the air out of the treatment boxes and form a very thin skin of low-volatile fluorides on the surfaces of the workpieces.

At a high temperature, the protective fluoride skin is reduced along with part of the reserve chromium fluoride, until the point is reached when the concentrations of hydrogen and hydrofluoric acid are equal to the concentration of reducing equilibrium for the working temperature. The composition of the halogen-reducing atmosphere is kept steady, thanks to the presence of the reserve of chromium fluoride, even if small amounts of hydrogen penetrate into the inside of the treatment chamber.

When workpieces with a basis of iron, nickel or cobalt, which can also have high chromium contents,

Fig. 1.—Installation used for bright annealing and brazing or for impregnation, with bright annealing, of steels and refractory alloys.



are heated to high temperatures in such atmospheres, they are annealed without any chemical disturbance of the surface areas and, after the boxes have been cooled, the parts are taken out straightaway with a very bright surface provided the treatment temperature has been high enough. With a temperature below 800-900°C., the surfaces of the parts may be coloured owing to the presence of unreduced fluorides.

In those cases where the materials treated are alloys containing elements of which the fluorides are both volatile and very stable (silicon, titanium, etc.), these elements are partially eliminated just below the surface. Moreover, when the treated materials are carburized, there may be a slight and regular decarburization of the surface zones owing to the presence of hydrogen in the treatment atmosphere and the absence of oxides on the surface of the parts. Finally, annealing in a halogen gaseous atmosphere when applied to parts already oxidized gives rise to a quantitative de-oxidization of surfaces, the metallic oxides submitted to the action of the fluoride-reducing atmosphere at high temperature being transformed progressively into fluorides, eliminated (silicon, titanium) or reduced (chromium, iron, nickel, cobalt . . .). In this case it is only necessary to see that the temperature of treatment is sufficiently high or that the oxide layer is not too thick. If these conditions are not fulfilled, several successive treatments may be necessary.

Most of the metal which ensures the formation of the reserve of fluoride is recoverable after each operation, only it is essential to add, between two operations, a small amount of acid or neutral ammonium fluoride.

It is possible to carry out an intermediate process between chromium diffusion and bright annealing of refractory alloys by applying a halogen treatment in which the addition of chromium to the parts is limited, for instance, by interposing a grid between the chromium applied and the workpieces under treatment. Such an operation is used, particularly, in the case of the protection by chromium diffusion of complex alloys, of which the surfaces would be made too brittle by extensive enrichment in chromium.

On the other hand, one or other of these operations can be associated with a further treatment integrated into the annealing: brazing of assembled parts, of which at least some portion is made of chromium alloy or of chromized elements, leads to particularly spectacular results when the operation is carried out in the atmospheres used for ONERA bright annealing or chromium annealing. We can also mention rediffusion, coupled with de-oxidation and homogenization, of electrolytic or chemical deposits of chromium and nickel on different materials, iron, copper, molybdenum . . . also the halogenized annealing of parts treated with hard chroming, or the bright annealing of the inside of hollow articles obtained by nitric hollowing-out of chromized objects. Finally we can mention the impregnation with metals, such as copper, of sintered products rich in chrome; sintered chrome articles or sintered iron parts with porous chromized finish.

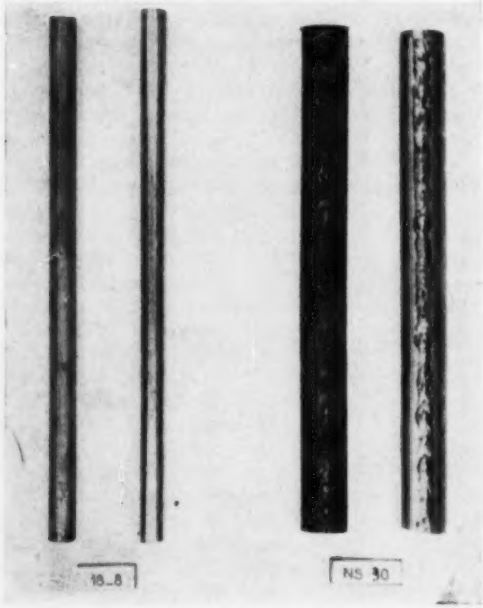


Fig. 2.—(left) Stainless alloy tubes, bright annealed (untreated samples shown on left in each case).

Fig. 3.—(below) Assembly of refractory alloy parts, Nimonic 75 and HS 31 brazed with de-oxidizing bright annealing (induction heated).



Typical examples of bright annealing

Bright annealing of tubing in 18/8 *steel.* The case in question relates to high-temperature annealing (about 1,100°C.), without any oxidation, of the outside of tube assemblies, so that there is no danger of contamination in service by oxide particles liable to become detached and so that direct electrolytic polishing of the parts can be done after annealing (passivation treatment). This case is particularly easy to solve and there is only the one problem of sizes of the containers for treatment. When annealing without oxidization or de-oxidizer is applied more particularly to the inside of tubes, certain specific measures must be considered, *e.g.* the parts can be heated in a salt bath with a halogen-reducing mixture flowing through the inside of the tubes, the halogen acid content of the mixture being progressively reduced (passage of gas at controlled temperature over chromium impregnated with chromium fluoride). Such atmospheres are also suitable for welding or plating chrome alloys.

Protective de-oxidising annealing for welded assemblies. In those cases where refractory alloy parts containing welds have to undergo a relieving annealing treatment at high temperatures (welded tubes, distributor blading, combustion chambers, etc.), the use of annealing atmospheres similar to those for bright annealing or chromizing-annealing makes it possible to eliminate oxides which may be present on the inside or outside of the welded areas, and so leads to an improvement in the behaviour of the parts. When treatment is carried out under conditions giving rise to chrome enrichment of the surface areas this allows of an improvement in the behaviour of the parts towards certain reagents, particularly sulphuretted hydrogen in kerosene, or to an increase in resistance to oxidization at high temperatures. Fig. 2 shows pieces of tube, with and without original oxidation, which have been bright annealed in fluoride atmosphere.

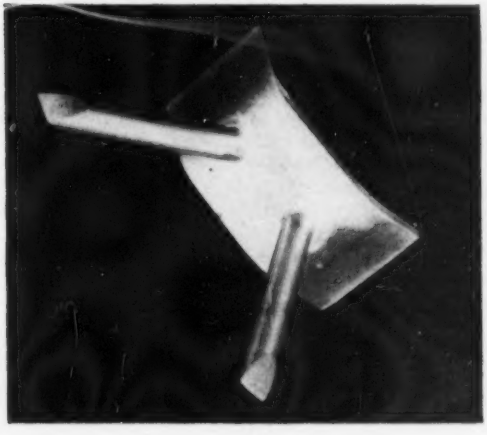
Brazing during bright annealing of assemblies containing elements made of stainless or refractory alloys. The use for brazing of atmospheres, as described above for bright annealing or chromizing-annealing of refractory alloys, allows of assemblies being obtained of exceptional quality and with a bright finish on the treated pieces. The surfaces of the parts are indeed quantitatively deoxidized before the substance used for brazing is fully melted, whether it be copper, copper alloys, silver-palladium, silver-manganese . . . In this way, and without the addition of a flux to the brazing material used, we can obtain assemblies of very many chromized materials or made up of items in sintered non-porous chromium, of hard carbides, or alloys rich in chrome, 18/8, Nimonic materials, Hastelloy, etc. In addition it is possible to get excellent brazing of very refractory metals or alloys, molybdenum, tungsten, etc., by using chromium alloys as brazing material, melting point 1,150-1,375°C. In this case the fluoride-reducing atmosphere principally acts as a protection for the material used as the brazing agent. This operation can be performed simply by using iron boxes, melting point 1,550°C., heated by the usual methods, or better still by induction heating.

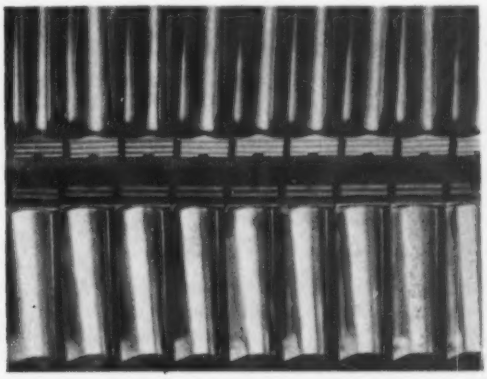
Figs. 3 and 4 show, respectively, assemblies brazed in fluorized atmosphere by bright annealing and chromizing-annealing. Fig. 3 shows an assembly of refractory alloys HS 31-Nimonic 75 brazed with copper, while Fig. 4 shows an assembly of molybdenum parts with chromized iron brazed with 18/8 stainless steel.

(*Continued in page* 116)

Fig. 4.—(*below*) *Assembly in molybdenum and sheet of chromized iron brazed with* 18/8 *at* 1,400°C. *approx.*

Fig. 5.—(*right*) *Turbo-reactor blades, skin annealed by bright annealing.*





FINISHING POST

A SELECTION OF READERS' VIEWS COMMENTS AND QUERIES ON METAL FINISHING SUBJECTS . . . . .

Salt Spray Testing

Dear Sir,

While we would agree with the opinion expressed by Mr. F. W. Dishley (in his letter appearing in the January issue of METAL FINISHING JOURNAL) that there is need for care in the interpretation of salt-spray tests, we would suggest that properly used, the salt spray, and more particularly its acetic-acid modification, can give a useful indication as to the relative durability of a finish. For although it may not be possible by the use of the salt spray to determine the potential life of a finish under actual service conditions, it does enable samples which are likely to fail in service to be readily detected.

The comments made by Mr. Dishley in his letter apply not only to the salt spray, but to other accelerated corrosion tests in which conditions in the test cabinet differ from those to which the components would be subjected in service. In interpreting the results of any corrosion test, this difference must, of course, be borne in mind.

Yours faithfully,

A. F. Brockington.

W. Canning and Co. Ltd.,
Great Hampton Street,
Birmingham, 18.

Polishes for Chromium Plate

Dear Sir,

With reference to the statement made by " Platelayer " in the paragraph headed " Acid Comment " in the January 1959 issue of METAL FINISHING JOURNAL, I would like to draw his attention to the " Bufft " series of metal polishes, manufactured and marketed by John Wilkins and Co. Ltd., 231-243 St. John Street, London, E.C.1.

These polishes are made in two grades, one for silver and similar soft metals, and one for chromium plate and other hard surfaces. The polishes consist of emulsified solvent/wax/water pastes into which appropriate abrasive powders have been dispersed. In addition, a quantity of a grease, either lanolin or petrolatum, is incorporated. The latter ingredient produces in use a thin protective film over the polished surface which has been found by independent observers to be remarkably efficient in retarding the tarnishing of silver, particularly in foggy weather, and the rusting and general corrosion of porous nickel/chromium deposits on steel.

I would add that the above polishes were developed by myself in the course of my duties as technical director of the John Wilkins Group of companies, but I am no longer connected in any way with the Group.

Yours faithfully,

S. Torrance.

6 Gresham Gardens,
London, N.W.11.

Platelayer has commented in reply :

Actually what I had in mind was the possibility of producing polishes containing inhibitors of the chemical type rather than materials which leave a protective film over the polished surface. These frequently detract from the brilliance of the finish, tend to collect dust and sometimes impair the ease with which polishing can be carried out because of the lubricating effect of the film-forming constituent.

However, I have obtained a tube of the polish and found it to be very good, although it will take a little time to evaluate its performance in practice.

New Thermo-Chemical Techniques - 1

(*Continued from page* 115)

Skin-annealing of gas-turbine blades.[2] The alloys for gas turbines of the 80/20 nickel chrome type hardened with titanium aluminium are very subject to violent and irregular cold working during machining. Parts made of these alloys are therefore generally submitted, after machining, to a short high-temperature annealing (1,080-1,100°C.), called " skin-annealing," this being done either in a salt bath or in very pure hydrogen. Owing to the very great affinity to oxygen of the various constituent elements of the alloys in question, it is difficult to avoid oxidization of the surface of the components or penetration of parasitic elements during annealing. When treatment is done under the conditions previously described, the parts come out in a very bright condition and definitely not oxidized (Fig. 5). They can then be polished electrolytically for structure control, without any prior mechanical preparation.

References

(1) P. Galmiche, *Rev de Metallurgie*, July 1954, p. 489.
P. Galmiche, *Metal Treatment*, February 1955, p. 79.
(2) ONERA, B F 1,074,096—4/2/53.
(3) P. Galmiche, *La Recherche Aeronatique*, July 1957, p. 27.
ONERA, B F 1,134,763—13/5/55.

FINISHING
NEWS REVIEW

METAL FINISHERS TO MEET IN BRIGHTON

Hotel Metropole Venue for April Conference

THE Metal Finishing Conference, held at Torquay last year, returns to Brighton for the 1959 venue, due to be held from April 8-11. The 1958 meeting was again a record in the number of full-time resident delegates, and it is expected that a still larger attendance will be achieved at Brighton where the Hotel Metropole has been booked to provide every facility. A warm welcome has been extended to the Institute by the Mayor and Corporation of the town.

The technical programme of the conference, detailed below, caters for the greatest possible variety of interests within the industry, and there will be the usual opportunities for informal social contacts and discussions in addition to the more formal evening functions. A separate programme of entertainment for the benefit of ladies attending as guests of delegates has been arranged.

Programme

Wednesday, April 8. Hotel Metropole.

2.30 p.m.—Conference opens. *1st Technical Session.*

(a) **Treatment of Aluminium.**

(1) "The Production of Coloured Anodic Films without the Use of Dyestuffs." By J. M. Kape and E. C. Mills.

(2) "Making Mirrors by Bright Anodising Pure Aluminium," by J. J. Dale L. H. Esmore and L. J. Howell.

(b) **Precious Metals:**

(3) "Some Experimental Observations on the Effect of Addition Agents on Stress and Cracking in Rhodium Deposits," by F. H. Reid.

(4) "Some Observations on Silver Anodes," by R. R. Benham.

(5) "Electroless Palladium Plating," by R. N. Rhoda.

(6) "Electrodeposition of Platinum from Chloroplatinic Acid," by R. H. Atkinson.

Royal Pavilion.

Evening—Reception and Dance by invitation of the Mayor and Corporation of Brighton.

Thursday, April 9. Hotel Metropole.

Morning—*2nd Technical Session:*

(a) **Nickel Plating**

(7) The Properties of Bright Nickel Electrodeposits in Relation to the Period of Service in the Plating Bath: III — Composition and Microstructure," by J. Edwards.

(8) "The Deposition of Nickel from Nickel Carbonyl," by L. W. Owen.

(9) "Rapid Quantitative Methods for Determination of Brighteners, Levellers and Anti-pitting Agents in Nickel Electroplating Baths" by H. Szmidt, T. Zak and Zb. Kwiatowski.

(b) **Alloy Plating**

(10) "Electrodeposition of Copper-Nickel Alloys," by B. H. Priscott.

(11) "Bronze Plating from Modified Stannate Baths," by W. T. Lee.

1.00 p.m.—Luncheon.

Afternoon—*3rd Technical Session:* **Embrittlement, Fatigue and Hardness**

(12) "Properties of Nickel Electrodeposited from a Sulphamate Bath," by D. A. Fanner and R. Hammond.

(13) "Brittle Fracture of Ultra High Tensile Steels in Relation to Surface Coatings," by R. L. Samuel and N. A. Lockington.

(14) "Hydrogen Embrittlement of Steel by Pickling and Cadmium Plating," by K. Sachs and S. H. Melbourne.

(15) "Hardness of Electrodeposited Speculum Metal and other Tin-Copper Alloys," by V. Ramanathan.

Evening—The Fifth Hothersall Memorial Lecture will be delivered by Professor R. S. Hutton.

Friday, April 10. Hotel Metropole.

Morning—*4th Technical Session:* **Fundamental Studies and Techniques**

(16) "Structure of Iron and Chromium Electrodeposits on Copper Single Crystals," by A. K. N. Reddy and H. Wilman.

(17) "An Electrochemical Method of Obtaining an Index of Porosity of Metal Coatings," by M. Clark and S. C. Britton.

(18) "Optical Techniques for Studying Metal Surfaces," by O. S. Heavens.

(19) "Some Techniques in Studying the Rates of Deposition and Formation of Inorganic Films on Metal Surfaces," by H. R. Thirsk and W. K. F. Wynne-Jones.

(20) "A Resistance Method for Studying Rates of Reaction during Chemical Polishing," by T. de Gromoboy and L. L. Shreir.

1.00 p.m.—Luncheon.

Afternoon—*5th Technical Session:* **Organic Finishing**

(21) "Developments in Metal Pre-treatment for Organic Finishes," by R. E. Shaw.

(22) "Measurement of Paint Finishing Costs," by H. H. Norcross.

(23) "Recent Advances in Plastic Coatings for Metals," by D. E. J. Cunningham.

(24) "The Impact of Organic Chemistry on Metal Finishing," by R. L. Yeates.

Evening—Conference Dinner and Dance.

Conference Dinner and Dance

The charge for the Conference dinner and dance is included in the full hotel charge. Members wishing to obtain additional tickets for this function in order to entertain guests can do so.



LORD MILLS TO OPEN FACTORY EXHIBITION

LORD Mills, Minister of Power, will open the 1959 Factory Equipment Exhibition, to be held at Earls Court from April 7-17.

Machinery to meet the demands of many industries will be on show. Exhibits will cover a wide range, including machinery for drilling, grinding, handling, loading, storage, metal cutting, sorting and feeding, spraying and finishing, and assembly lines.

PLASTIC JACKET FOR PIPELINE

U.S. Development for Protection Under Ground

DEVELOPMENT of a steel pipeline protected against external corrosion by a plastic coat has been announced by the Pipe Division of the Republic Steel Corporation, Youngstown, Ohio, U.S.A.

Called Republic X-Tru-Coat, it is claimed to be the first steel pipe in the industry to be coated with an extruded plastic, and is designed for use as buried pipeline in the gas, oil and chemical industries.

Full scale production is underway in sizes from ¾-in. O.D. to 4½-in. O.D. in various wall thicknesses, and with coatings of polyethylene from 0.025-in. thickness and up. Development and research work has taken four years the company says.

Republic X-Tru-Coat is made from selected butt weld or electric weld pipe. An elastic adhesive undercoating is hot applied to the pipe. Then a controlled thickness of polyethylene plastic is extruded over the undercoating. The coating is cut back from the end for welding or for the use of tools on threaded joints. It is claimed that the key to the successful use of the process in this field is the specially developed "live" elastic undercoating which, because of its chemical composition, never sets up or becomes hard and brittle as do many bonding agents. It remains "live," allowing the pipe to be flexed or bent without destroying the bond, according to the company's pipe engineers.

In addition, the company says, the undercoating is unaffected by extreme seasonal temperatures, and retains its ability to seal accidental cuts or abrasions. At the same time, it also prevents underfilm migration of moisture at the ends of the plastic coating, or in cases of severe coating damage. The outer polyethylene coating also has this flexibility, permitting the coated pipe to be bent or flexed without destroying the coating or causing cracks, according to Republic Steel. Field joints can be made with ordinary pressure sensitive tape and primers.

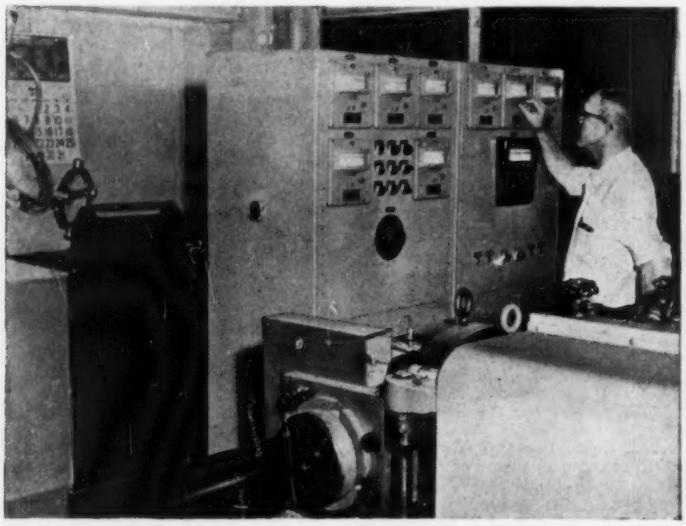
The pipe and coating are both produced at the company's pipe mills in Youngstown, and the coating has previously been used in the manufacture of Dekoron-coated welded steel electrical conduit.

Waverley Medal Again This Year

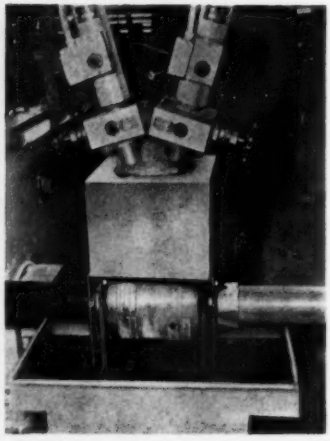
THE Butterworth journal *Research* is this year sponsoring the Waverley Gold Medal essay competition for the seventh year in succession. The competition is designed to encourage and promote improved and more effective reports of scientific and technical work.

The Waverley Gold Medal, named after and bearing the coat of arms of the late Lord Waverley, together with £100 will be awarded for the best essay of about 3,000 words describing a new scientific project or practical development giving an outline of the scientific background, the experimental results and the potential application of the project or process in industry. The essays will be judged for technical content by specialists in the subject, for clarity of presentation, and for style. Two other prizes will also be awarded.

Entries should be posted to reach The Editor of *Research*, 4/5, Bell Yard, London, W.C.2., not later than July 31, 1959. (Further details can be had from this address).



(Below)—The pipe passes through the adhesive applicator, and (left) — continues through the head of the plastic extruding machine.



Stresa Electro-Heat Meeting

Britain Represented at Fourth International Congress

NINETEEN papers by British authors are to be presented at the 4th International Congress on Electro-heat to be held at Stresa, Italy, from May 25-29. Altogether, 199 papers will be given to the 10 sections of the Congress. The number of delegates notified at the end of 1958 was 580, of whom 39 are British, and among the authors of papers are Dr. A. G. Robiette, L. W. Webb and A. G. Allen (Birlec Ltd.), J. W. S. Payne (B. T.-H. Co. Ltd.), F. L. Gladwin, M. Gibbs and R. H. Barfield (Wild-Barfield Electric Furnaces Ltd.), M. Donovan and G. M. Hogarth (General Electric Co. Ltd.), and H. A. P. Cadell, S. Scholefield, H. Jackson, J. W. Moule and A. Haddock from the regional electricity boards.

The British national committee on electro-heat was re-organized about a year ago. Besides the British Electrical Development Association and D.S.I.R., its members now include (in addition to bodies such as the B.E.A.M.A. and user organizations) the various metallurgical institutions.



I.W.S. Foremen's Tour

A TWO-WEEK study tour of German Industry for foremen and forewomen from British industry has been organized by the Industrial Welfare Society.

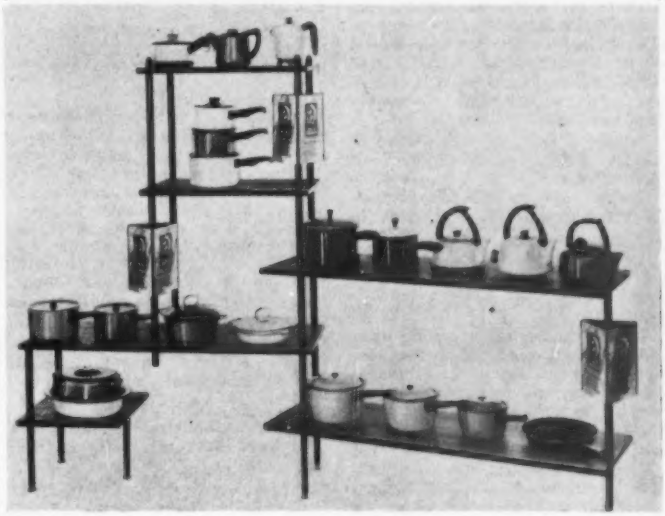
The tour will take place from April 11 to 24 and the party, limited to 40, will be based on Dusseldorf. A wide variety of industries will be studied, most of the visits to factories including a tour of the works followed by discussion with management and employee representatives. At the end of the tour there will be a summing-up discussion with the assistant labour attache at the Embassy British in Bonn and the training officer of a German employers' federation.

NARDA U.S.A.F. ORDER

THE Narda Ultrasonics Corpn. of Westbury, L. I., U.S.A. has been awarded a U.S.A.F. contract to build fully automatic "push-button" ultrasonic vapour degreasers, designed for cleaning aero engine parts.

The equipment can be used for many types of maintenance in which degreasing is necessary, such as spark plugs, valves, hydraulic parts and bearings. In addition, water and detergent solutions or alkaline cleaners can be employed in the same machine alternately for special purpose cleaning.

V.E.D.C. Display for Stockists



THE handsome display stand seen in the picture above is the latest development in the promotion plans of the Hollow-ware Division of the Vitreous Enamel Development Council. Stockists of the enamelware products made by the four manufacturers who constitute the Division will be able to obtain both the stand and expert advice in dressing it from the Council's bureau at 28 Welbeck Street, London, W.1. Sales staffs of stockists are being invited to a series of "educational receptions" so that they can see for themselves the advantages of the finish and be given information on some of the technical aspects of vitreous enamel. The "receptions" began in London last month.

RATES CHANGE FOR PLANT LIKELY

THE 30-year old list of machinery and plant liable to local rates under the Rating and Valuation Act, 1925, has been under the microscope by a committee of the Ministry of Housing and Local Government. Their report has recently been published under the title "Rating of Plant and Machinery," available from H.M.S.O., price 2s. 6d. net. If approved, the list will come into force on April 1. The committee say that industrialists have complained of a tendency in recent years for more and more plant and machinery to be rated beyond what was intended by Parliament in 1925, and have proposed a number of ways in which the rating liability of plant might be restricted. On some of the proposals, the committee have expressed disagreement, but one thing they are unanimous about is that movable plant should not be exempted from rating. The committee have not reached agreement on two other proposals. One was to exempt plant which moves or rotates, and the other was to exempt plant below certain dimensions which in ordinary business practice is moved about. They Minister of Housing, Mr. Henry Brooke, will draft new regulations for Parliamentary approval some time this month.



IDEAL HOME EXHIBITION

There is hardly one part of the modern home in which metal in some form or other is not used, and at this year's *Daily Mail* Ideal Home Exhibition held at Olympia earlier this month, this was amply demonstrated.

Besides boilers, washing machines, cookers and so on, in which metal plays a vital part, there was a wide array of products, kitchen gadgets, gardening equipment and tools of all kinds.

Stainless steel sinks and sink units, together with other kitchen gear, were displayed by Leisure Kitchen Equipment Ltd.

The " Speediwork " range of plastic and metal domestic aids was exhibited by the Bearston Metal and Plastics Co., and included fruit and vegetable cutters, waffle-making irons, whisks, and non-sticking siliconised omelette pans.

R. G. Bennett and Co. Ltd., too, had a large selection of kitchen equipment on show, including a stainless steel spatula, openers, mincers, slicers, potato chippers and a big range of wirework. Druce and Co. Ltd.'s " Tala " display emphasised the importance of colour in the kitchen, with an extensive array of chippers, cutters, etc. The famous " Jury " range of glass-on-steel saucepans, teapots, skillets, etc., were displayed by Klin Products.

Quickfri showed their pan which roasts, fries and boils ; and Darragh, Small and Co. Ltd., exhibited the " Teaboy, " a combination kettle and teapot infuser. Made of an alloy and bakelite, there are two models for gas or electricity.

I.S. Dearden and Sons, Ltd., showed their " Monogram " range of stainless steel cutlery, and in addition exhibited some of the products of F.A. Kirk (Cutlers) Ltd. Among these were barbecue sets, canteens of cutlery and carving sets, all in forged stainless steel.

An all-metal ironing board, the Golmet Vanguard, was displayed by Golmet Ltd. Adjustable to 14 different heights, it is made entirely of thin gauge metal.

MEETINGS OF THE MONTH

March 10

Institution of Chemical Engineers (North Western Branch). Symposium on Fluidisation, " in the Chemical Engineering Building, Manchester College of Science and Technology, Jackson Street, Manchester. Whole day meeting.

March 17

Institution of Mechanical Engineers (Automobile Division) James Clayton Lecture " The Founding of a New Automobile Industry," by Dr. Wilfredo P. Ricart, at 1, Birdcage Walk, London, S.W.1.

March 18

Institute of Vitreous Enamellers (Southern Section). Annual General Meeting, followed by " Influence of Chemical Composition of Enamel on its Alkaline Resistance, ' by A. N. Revell (Main Enamel Mfg. Co.), at the Howard Hotel, Norfolk Street, London W.C.2. 7.15 p.m.

Society of Chemical Industry (Corrosion Group). " Economic Aspects of Corrosion, " by A. Keynes, at 14, Belgrave Square, London, S.W.1. 6.30 p.m.

March 19

Institute of Vitreous Enamellers (Northern Section). " Sheet Steel for Enamelling, " by Dr. W. H. F. Tickle, at the Old Nag's Head Hotel, Manchester.

Society of Instrument Technology (Tees-side Section). " Flow Measurement : Some Problems and Devices of Special Interest, " by W. J. Clark, at the Cleveland Scientific and Technical Institute, Corporation Road, Middlesborough. 7.30 p.m.

March 20

Oil and Colour Chemists Association (Midlands Section). " Microbiological Experiences with Polymers, " by A. E. T. Neale, at Mander Bros., Wolverhampton. 6.30 p.m.

March 24

Society of Chemical Industry " Molecular Weights of High Polymers ", by Dr. R. S. Lehrle and Dr. F. W. Peaker, at the Birmingham and Midland Institute, Birmingham. 6.30 p.m.

INSTITUTION FOR P.E.

THE Incorporated Plant Engineers has changed its name to the Institution of Plant Engineers. The body already holds a licence to dispense with the word " Ltd."

April 2

Birmingham Paint, Varnish and Lacquer Club. " The Plain Man's Guide to High Polymers, " by S. A. Ray, at the Imperial Hotel, Temple Street, Birmingham. 7.50 p.m.

April 6

Institution of Electrical Engineers. " Co-operation between the Electricity and Gas Industries, " informal discussion opened by F. C. Smith, M.B.E., at Savoy Place, 5.30 p.m.

April 7

Institute of Vitreous Enamellers (Scottish Section). " Sheet Steel for Enamelling, " by Dr. W. H. F. Tickle, at the Plough Hotel Stenhousemuir.

April 8

Institute of Metal Finishing (Midland Branch). Works Visit to W. T. Avery Ltd.

Association of Supervising Electrical Engineers (Birmingham Branch). " Electrical Safety " by J. L. Leighton, at the Exchange and Engineering Centre, Stephenson Place, Birmingham. 7.30 p.m.

April 14

Institution of Plant Engineers (Manchester Branch). " Ventilation in Industry, " by G. A. Rooley, at the Engineers' Club, Albert Square, Manchester. 7.15 p.m.

Society of Chemical Industry (Corrosion Group). Spring Lecture, " Studies of the Influence of Chemical Factors on the Corrosion of Metals, " by Prof. W. Feitknecht, at 14, Belgrave Square, London, S.W.1., 6.30 p.m.

April 16

Institute of Vitreous Enamellers (Northern Section). Annual General Meeting and Social, at the Old Nag's Head Hotel, Manchester.

April 17

Plastics Institute (Midlands Section). " Development of Fire and Heat Resistant Materials, " by W. Wilson, at the James Watt Institute, Great Charles Street, Birmingham. 6.30 p.m.

April 24

Institute of Vitreous Enamellers (Southern Section). Dinner at Kettner's Restaurant, followed by a visit to Cinerama. 7.15 p.m.

April 28

Institute of Vitreous Enamellers (Scottish Section). Works Visit to the British Aluminium Co. Ltd.,

TECHNICAL *and* INDUSTRIAL APPOINTMENTS



Following upon the change of control of **The British Aluminium Co. Ltd.**, Lord Portal and Mr. Geoffrey Cunliffe, formerly chairman and deputy chairman respectively, have left the boards of that company and all its subsidiary and associated companies.

Sir Ivan A. R. Stedeford has been elected a director and chairman of the board of The British Aluminium Co. Ltd., and Mr. Richard S. Reynolds has been elected a director of the company.

The following staff changes have been made at the company's rolling mills : Mr. J. A. Richmond has been appointed deputy manager at Falkirk taking effect from July 1, 1959. He has been nominated to succeed Mr. Field as manager at Falkirk when the latter retires on January 23, 1960. Mr. T. D. Rees has been appointed deputy manager at Latchford with effect from next May 1. Mr. R. L. C. McDonald has been appointed assistant manager at Warrington ; Mr. F. C. Foskett has been appointed chief production superintendent at Milton ; Mr. N. MacDonald has been appointed deputy chief production superintendent at Milton ; Mr. D. Lowe has been appointed superintendent of the experimental department at Milton.

Consequent upon the retirement of Mr. H. W. L. Phillips in September next, the following staff changes have been made at the research laboratories, Chalfont Park, all to take effect from next September 12. Mr. A. C. Coates has been appointed assistant director of research (chemical). He will deputise for Dr. Pearson in the latter's absence. Mr. P. C. Varley has been appointed assistant director of research (metallurgical). Dr. C. E. Ransley will be given the title of senior research metallurgist and Dr. F. A. Champion will be given the title of senior research chemist with effect from September 12.

* * *

Following the recently announced retirement of Mr. J. Horridge on medical grounds, the appointment of Mr. J. F. Willsher as general works manager of **George Kent Ltd.** has been announced.

Mr. Willsher joined the company in 1947 after Army service ; in 1951 he was appointed production controller and a year later production manager. In 1955 he was appointed manager of the instrument division,



J. F. Willsher
(George Kent)

a post he held until taking over his present position. Mr. Willsher served on the council of the Luton Management Association for six years and is now a representative member of the local branch of the British Institute of Management.

* * *

Mr. J. M. Storey, managing director of Dewrance and Co. Ltd., has been appointed vice-chairman of **The Council of British Manufacturers of Petroleum Equipment.**

Mr. Storey was awarded the C.B.E. in the New Year Honours List, and was leader of the Council's " Economic, Technical and Goodwill Mission " to Canada in 1957.

* * *

Mr. D. G. Ashton Davies has recently taken up an appointment as sales manager of the Instrument Division of **E.M.I. Electronics Ltd.** Mr. Ashton Davies has had considerable experience in the electronics industry, having been employed with Marconi Instruments Ltd. and Mullard Ltd. He came to E.M.I. from British Physical Laboratories. Ltd

Another E.M.I. Electronics appointment is that of Mr. Charles Kramskoy as chief engineer of the Commercial Division. He was previously responsible for the development work on the EMIDEC 2400 computer.

* * *

The Wakefield Castrol Group, 46, Grosvenor Street, London, W.1., have announced the appointment of Mr. S. H. Oliver as assistant manager of their group purchasing department.

Mr. Oliver joined W. B. Dick and Co. Ltd., in 1932 and entered his present department when that company became a member of the Wakefield Group some years later.

* * *

Sir Gordon Russell, C.B.E., M.C., R.D.I., F.S.I.A., has intimated his decision to retire from the directorship of the **Council of Industrial Design** at the end of 1959. His decision has been accepted by the Council with reluctance and with appreciation of the great contribution Sir Gordon has made to its work throughout its entire life ; he was an original member of the Council when it was created in 1944 and was appointed its director in 1947.

Mr. Paul Reilly, who has been deputy director since 1954, has been appointed by the Council to succeed Sir Gordon Russell.

* * *

Mr. A. R. Woodward, B.Sc., A.F.R.Ae.S. has been appointed head of the Joining Division of the Development Department of **Aluminium Laboratories Ltd.,** Banbury, to be responsible for the investigation and development of all methods of joining aluminium, particularly welding. Mr. Woodward joined Aluminium Laboratories Ltd. in 1948 and worked for some years on the mechanical properties of aluminium, including fatigue.

(*Continued in page* 122)

A. R. Woodward.
(Aluminium Laboratories)





Technical and Industrial Appointments

(*Continued from page* 121)

The Hon. J. Kenneth Weir, C.B.E., chairman of G. and J. Weir Holdings Ltd., and G. and J. Weir Ltd., has been elected a director of **The International Nickel Company of Canada Ltd.,** to fill the vacancy caused by the retirement of his father, The Rt. Hon. Viscount Weir, P.C., G.C.B., who had served as a director since 1928.

Mr. Weir is also a director of Peacock Brothers Ltd., Montreal, the National Bank of Scotland and the Dunlop Rubber Co., Ltd. and chairman of William Simons and Co. Ltd., and Weir Foundries Ltd.

* * *

Fescol Ltd., London, N.7 have announced the retirement of Mr. R. E. Wilson, managing director. Mr. Wilson joined the company in 1928 and during his long service has guided it through a period of considerable expansion, during which business has greatly increased and its organisation enlarged by the addition of factories in Yorkshire, Scotland and the Midlands. The overseas licensees in France and Australia were also set up under his management. He was appointed manager in 1932, a director of the firm in 1934, and managing director in 1941.

Mr. Wilson is a full member of the Institution of Mechanical Engineers and the Institution of Production Engineers.

J. K. Weir
International Nickel



Succeeding him as managing director is Mr. F. B. Strachan, who joined the firm in 1925 on the financial side and was appointed secretary in 1928. He has been assistant managing director since 1951.

* * *

Mr. Sydney T. Clark was recently appointed managing director of **Canatlas Steels (England) Ltd.,** U.K. agents for Atlas Steels Ltd., Welland, Ontario, Canada.

Mr. Clark's long experience covers every aspect of steelmaking, including research work on stainless steels. During the war he was deputy director for alloy and special steels, and later director of statistics in the Iron and Steel Control. Later he served as assistant commercial director of the British Iron and Steel Federation, and in 1947 was awarded the O.B.E.

Coinciding with Mr. Clark's appointment, the company has acquired increased warehouse facilities at Luton, where it already has over 8,000 sq. ft. of warehouse space.

The following staff announcements have also been made : Mr. W. A. Leslie continues as director and sales manager ; Mr. F. Baden is now works manager in London and Mr. C. W. Hay has succeeded him at Port Glasgow. Mr. A. E. Lockley is the new works manager in Huddersfiled, and Mr. R. F. Burke is now works manager of the Midlands plant.

* * *

The Board of Trade have announced that Mr. A. N. Halls, M.B.E., the regional controller, Midland Region, will be temporarily attached to the headquarters division of the Board of Trade dealing with the distribution of industry, to promote industrial development in areas of high and persistent unemployment.

* * *

Mr. P. G. Smyrk has been appointed joint manager of **Johnson, Matthey and Co. Ltd.** He has hitherto been manager of the export division of the company and a director of several of its overseas subsidiaries.

NEW COMPANIES

"Ltd" is understood, also "Private Co."
Figures = Capital, Names = Directors, all unless otherwise indicated.

F.D.C. Products, 35, High Street, Kingswinford. January 23. £100. To carry on bus. of manufacturers of rolled metal strip coated with plastic, etc. Geoffrey E. Fletcher, Eric S. Cockayne, Richard Daker, Gordon G. Smart.

Plasinter, Progress Works, Holyhead Road, Wednesbury. January 23. £2,500. To carry on bus. of manufacturers of and dealers in and workers in plastic coated steel products and other goods, etc. James J. Hurley, Stanley J. Hurley, Geoffrey J. Hurley.

Gt. Yarmouth Galvanizing, Bostons Yard, Mariners Road, Great Yarmouth. January 29. £1,000. Thomas R. V. Playford, George E. Playford.

Enamel Spray, Crown Chambers, 118, Chancery Lane, W.C.2. January 30. £2,000. To carry on bus. of metal finishers, etc. Stanley T. E. Fiddy, Dennis Goodchild.

Lishmans of Ripon, 41, Kirkgate,, Ripon, Yorks. February 2. £2,000. To carry on bus. of manufacturers of and dealers in paints, enamels, etc. Walter Lishman, Edith N. Prentice.

Mapel (Overseas), 22, Queen Annes Gate, S.W.1. February 4. £100. To carry on bus. of the protection by cathodic or other methods of buried lines, pipes, jetties, foundations, foundation reinforcements, tanks, ships and structures whether of steel or other metals from damage or destruction due to corrosion or other natural agencies, and to establish research laboratories, etc. Kenneth P. Allpress, William H. G. Roach, Richard Y. Stevens, Michael Webb.

Pairman, Ballast Hill Works, Leighton Road, Byker Bank, Newcastle-on-Tyne. February 5. £2,500. To carry on bus. of cellulosers, paint sprayers, etc. Norman Pairman, Irene Pairman.

Reginald Lloyd, 2, Church Road, Stanmore, Middx. February 6. £100. To carry on bus. of manufacturers of and dealers in tinning and soldering compounds, and all articles and accessories used in connection therewith and in the engineering industry generally, etc. Leonard J. Bennett, Maurice G. Hardy.

G. Smith Enamelling and Plating, 382, St. John Street, E.C.1. February 9. £1,000. George E. Smith, Lionel Smith, Mrs. Ivy V. Sealey.

Yorkshire Anti-Corrosive, 16, Princes Street, Harrogate. February 10. £1,000. To carry on bus. of manufacturers of and dealers in chemical products, etc. Sidney Kiddle, Joan A. Kiddle.

From the Register compiled by Jordan & Sons Ltd, 16 Chancery Lane, London, W.C.2.

Latest Developments in PLANT, PROCESSES AND EQUIPMENT

Instrument for the Detection of Chlorine Residual

THE Amperometric titrator illustrated in Fig. 1 has recently been introduced by Wallace and Tiernan Ltd., Power Road, London, W.4., for determining small quantities of chlorine residual, free and combined chlorine being determined separately. The instrument makes it possible to determine the concentration of the different forms of available chlorine to within 0.01 p.p.m. Direct readings of concentrations are obtained, free from interference by temperature, colour, turbidity, iron, manganese and nitrites. Simple additions of buffer solution and potassium iodide allow the determination of free chlorine, monochloramine, dichloramine and total residual chlorine in one sample.

In use, the presence of free chlorine in the sample causes current to flow between two electrodes, as indicated by a sensitive microammeter. Phenylarsen oxide is added from a microburette until the current falls to a point where no further change is observed. The mono- and di-chloramine fractions are determined in the presence of suitable concentrations of potassium iodide and buffer solution, the liberated iodine being titrated against phenylarsene oxide. Temperature, colour turbidity and other interfering agents can be detected by the titrator, and its construction and operation make it suitable for a wide variety of uses. No special skill or training is required by the operator.

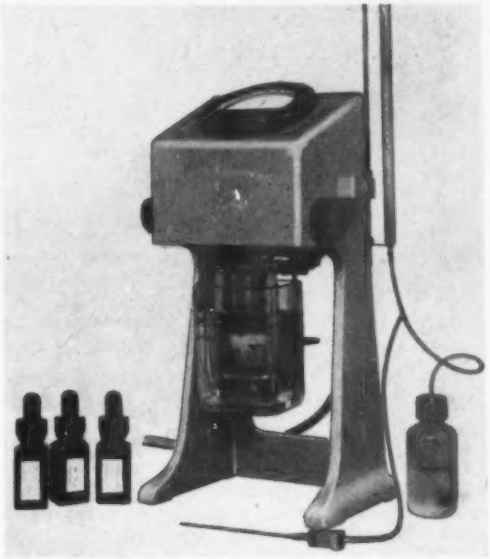


Fig. 1.—Direct readings of small amounts of chlorine residual can be obtained with this titrator.

Re-designed Range of Vacuum Pumps

THE "Microvac" range of rotary vacuum pumps manufactured by the F. J. Stokes Corpn., 5500 Tabor Road, Philadelphia, 20., Pa., U.S.A., has now been redesigned and is being marketed as the "H" series. The company says that the new series has a larger pumping capacity, improved gas ballast to minimize oil contamination, and is of more compact design. The overall height has been reduced by the introduction of an offset-angled piston-and-slide mechanism. Poppet exhaust valves have lengthened the life between overhauls and reduced operational noise. The pumps are dynamically balanced during assembly ; a completely automatic lubrication system incorporates the company's latest developments in shaft sealing. The guaranteed ultimate vacuum is 10 microns, but the company says that even better vacuums are normally attainable. A 5-h.p. motor provides a pump speed of 475 r.p.m. The displacement is 140 cu. ft. per min.

Instrument Measures Surface Roughness on Spheres

A NEW RJ "ball pilotor" illustrated in Fig. 2, has recently been introduced by the Micrometrical Mfg. Co., 345, South Main Street, Ann Arbor, Michigan, U.S.A. It provides for accurate measurement of surface roughness on all types of balls from $\frac{1}{16}$-in. to $1\frac{1}{2}$-in. dia. The range of sizes is achieved with the use of only 8 separate ball adaptors. The instrument incorporates a variable speed drive to ensure a constant surface speed in measuring balls of varying diameter. The company's standard "Profilometer Amplimeters," types QA and QC can be used with the equipment, and there is a bracket on the instrument to accommodate a standard MA tracer. Hoppers for use in production checking are also available if required. The equipment is completely portable.

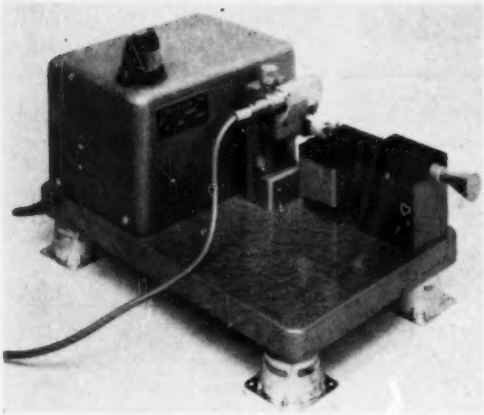


Fig. 2.—An instrument designed for the accurate measurement of surface roughness on spheres.

Agents in the U.K. for Micrometrical are Gaston E. Marbaix, Devonshire House, Vicarage Crescent, London, S.W.11.

Speed Reduction Pulley

THE "Andantex" speed reduction pulley illustrated in Fig. 3 has been designed for applications that require a sturdy and compact speed reducer for direct mounting on to the driven shaft. Basically, it follows the conventional sun and planet gear system, but the makers claim that a patented process used in keying and aligning the pulleys gives the Andantex many advantages over the conventional reduction unit.

When more than one multiple gear train is fitted around a set of central sun gears, very accurate positioning of the steel keys and keyways is required if each of the gear trains is to carry an equal load. In the patented method used for the Andantex pulley, the reduction unit is permanently assembled. With the pinions mounted and free to rotate on their shafts, adaptors are used in place of the planet shaft bearings, enabling the planet gears to be pre-loaded and set in relation to the central sun gears. The sub-assembly is used as a mould into which molten nylon is pressed to key the pulley to the shafts on setting. The adaptors are then removed and the correct bearings inserted. The slight elasticity of the nylon allows the bearings to give the pinions sufficient working clearance, thus equilibrating the load. The makers claim that among the thousands of units in use, no cases have ever been reported of a pinion bearing an excessive load.

Gears used in the unit are of the single helical type made from nickel-chrome steel. The shafts are mounted on ball and roller bearings. Ancillary equipment includes a torque limiter, that can be used as a clutch or as a change-speed device, remotely controlled or by hand, to ensure positive predetermination of the safe working load.

An important feature is the safeguard the Andantex provides for capital equipment against damage through overload or careless operation. The ancillary equipment provides a means for automatically limiting the torque, and if the nylon keys should shear, replacement is a matter of simply re-injecting new material into the keyway. A large range of speed ratios can be selected. The makers say the pulleys can run without attention for at least 30,000 working hours. They are made to transmit up to 80 h.p. in 16 sizes. Sole licensee for the manufacture and sale in the U.K. and Commonwealth countries is Furnival and Co. Ltd., Reddish, Stockport, Cheshire.

Cask Handling Truck

THE "Quinell" all-purpose truck illustrated in Fig. 4 has been designed for the movement of casks, drums, etc. It has a maximum capacity of 6 cwt. A grappling hook that can be adjusted vertically is used to secure the load, and the tyres

Fig. 3.—This speed reduction pulley has many novel features.



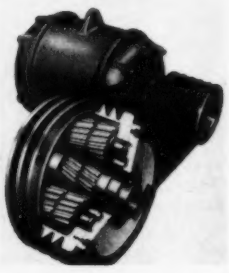


Fig. 4.—A cask handling truck with a capacity of 6 cwt

are claimed to be acid-resistant. The truck is manufactured by Cranmer Engineering Ltd., 45, New Cross Road, London, S.E.14, and has a length of 4½ ft. with a height of 2¼ ft. The cradle dimensions are 24 in. x 18 in. x 4 in. and the total weight is 44 lb.

Lining for Vessels Heating Corrosive Liquids

A NEW type of lining for vessels in which corrosive liquids are heated was announced recently by Cahn and Bendit Ltd., 51/55 Weymouth Street, London, W.1. It consists of flat impregnated graphite tiles shaped in such a way that when used as a lining in a cylindrical or similar vessel a space is formed between the back of the tile and the vessel By cutting the

supporting edges of the tiles, continuous channels can be formed so that steam or heat exchanging fluids can flow. The method makes use of the chemical inertness of graphite to many chemicals, and its good thermal conductivity. A tank lined with the tiles is shown in Fig. 5. The company says that such vessels have been used successfully by well-known Continental chemical manufacturers.

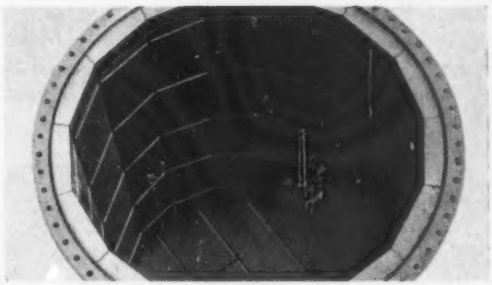


Fig. 5.—Graphite tank lining tiles can be adapted to provide a heating jacket.

Weld-Cleaning Fluid

A NEW weld-cleaning fluid for use with stainless steel and certain high chromium and nickel alloys, "Pelox," is being marketed by North Hill Plastics Ltd., Manley Court, Stoke Newington High Street, London, N.16.

In use, the liquid is applied to the discoloured area and the metal is immediately polished with a rotating stainless steel brush. The makers say the discolouration is removed instantly leaving a bright matt finish. Any residue from the dried-out liquid is simply removed with sponge and cold water. The liquid contains no skin irritants and protective clothing is not required.

The makers claim that 1 kg. will clean over 2,000 ft. of weld at a cost of about $\frac{1}{3}$ penny per ft. Additional advantages claimed are freedom from continued corrosive attack because the liquid is self neutralising and has an indefinite storage life.

Polishing and Buffing Lathe

THE new polishing and buffing lathe, the "Pensel," illustrated in Fig. 6, is now being marketed by Grauer and Weil Ltd., Hardwick Street, London, E.C.1. Spindle speeds can be changed simply by turning the housing at the front of the machine. There are no idling pulleys, and the system allows the driving motor to be permanently bolted to the body instead of being mounted on a movable platform, thus reducing the possibility of a short circuit. Since the machine is equipped with two drive motors, each having a separate control, two operators are able to work independently of each other.

Other points of interest are the double sealing on motors and bearings to render these completely dustproof, and the use of multiple vee belts for the transmission. As shown in the illustration, the machine can be supplied for use by a seated operator, particularly advantageous if female labour is employed. There is also a complete range of backstand equipment available if required. Further information is contained in a leaflet available on request from the company.



Fig. 6.—Separate controls are provided on this twin-drive polishing lathe.

Marking Method for Metal Surfaces

A NEW method of marking metal surfaces uses a duplicator stencil and an electro-chemical etching machine.

The method can be used to reproduce trade marks, identification numbers, etc. on metal goods of all kinds.

When the stencil is placed in contact with a metallic surface, words, figures and designs can be imprinted onto it. Providing a black-and-white original can be supplied, no matter how complex the original design may be, the design is reproduced faithfully in every detail on the stencil by an electric stencil cutter, the makers say. A source of light scans the original black and white design, and using a photo-electric cell, electrical impulses are generated causing the stencil to be perforated in the areas corresponding to the black portions of the original design.

The stencil, an addition to

(*Continued in page* 126)

Plant, Processes and Equipment

(*Continued from previous page*)

their " Vellatronic " range, has been developed by Ellams Duplicator Co. Ltd., 5 Dean Street, London, W.1.

Surface Inspection Aid

THE range of " Probe-Lite " viewing instruments manufactured by Engineering Developments Ltd., Mark Road, Hemel Hempstead, has been extended by the addition of an instrument, giving a magnification of 8 times, specially designed for examination of surfaces. Illumination is provided by a small bulb mounted in the lens housing, power being supplied by the standard torch battery handle used for the company's other products in the range. A resting pin is fitted to facilitate maintaining correct focal length while the magnifier is traversing a surface. Further details can be obtained from the company on application.

For the internal inspection of hollow objects the range has been extended by the introduction of two new " Mirotilt " probes, 12 in. and 24 in. in length.

A feature of the " Mirotilt " (an illuminated probe for inspecting the interiors of boiler tubes, I.C. engines, turbines, etc.) is that the angle of the mirror can be controlled by push button on the probe's handle. Power for the small bulb which illuminates the mirror and the area being examined are again supplied by the standard screw-on handle.

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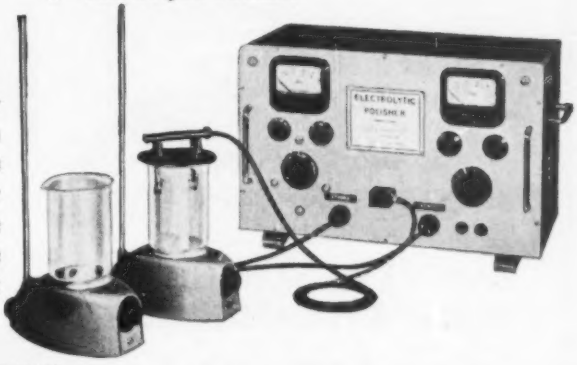
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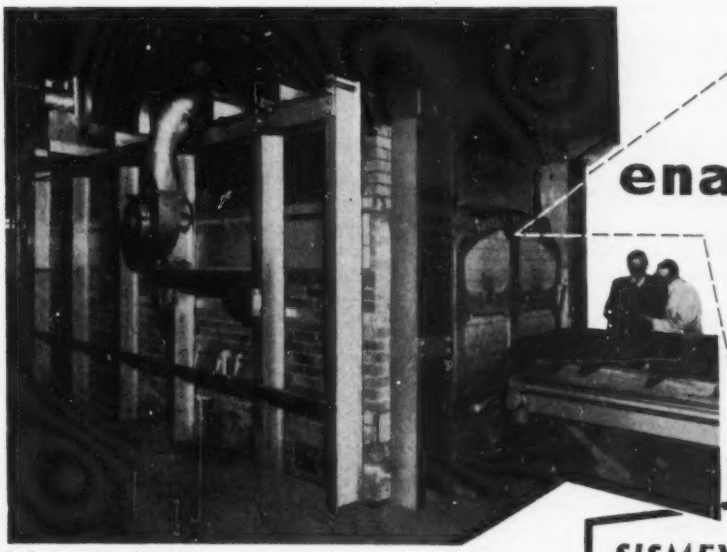


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